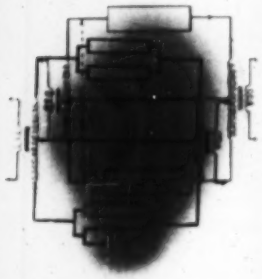
INSTRUMENTS AND CONTROL SYSTEMS

INSTRUMENTS AND CONTROL SYSTEMS



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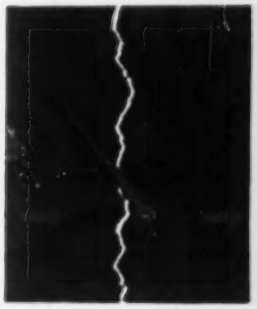

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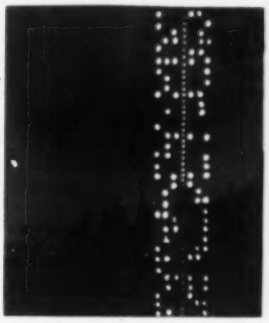

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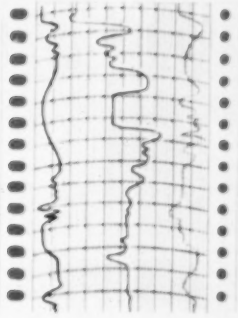

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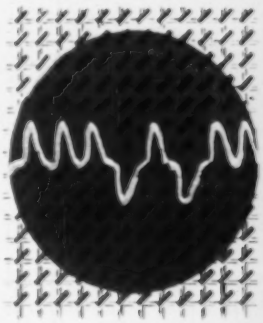

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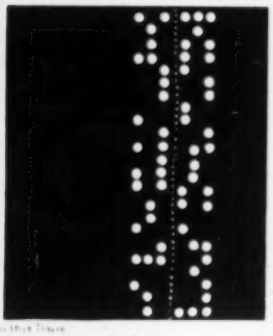

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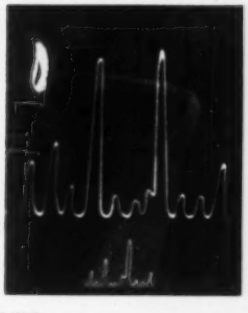

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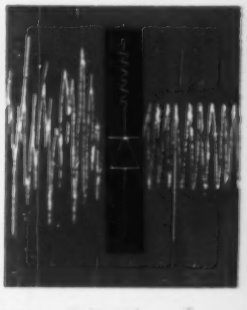

GPE Controls Model R790 **Electric Integrator**

gives you direct integrated 6-digit read-out of any flow that can be represented by a D.C. electrical signal—with accuracy to within ½ of 1% over flow turndowns of as much as 10 to 1. Chart planimetering is eliminated. Unaffected by temperature changes from −30° to +130°F. Designed for use with GPE Controls linear signal electric flow transmitters, but suitable for many other applications as well.

Long-time accuracy and dependability assured by jeweled integrator motor, precision-made low friction gears and counter. Requires little panel space.

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CIRCLE 1 ON READER-SERVICE CARD

THERMOCOUPLE PYROMETERS
BY LEWIS

Sturdy, Accurate, Dependable Instruments for Indicating Temperatures of

AMBIENT AIR
CARBURETORS
CRANK CASE
ENGINE EXHAUST
FUEL
GASES
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LIQUIDS
MOLTEN METALS
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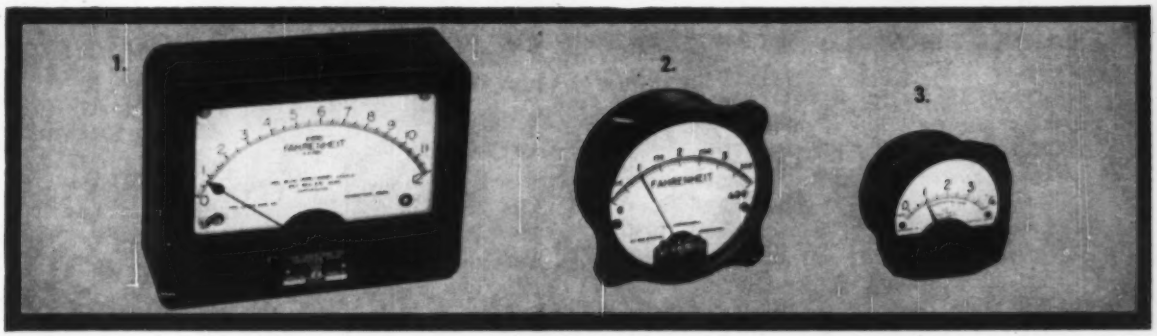
and many others in Automotive and Industrial Applications.

1. **Model 58PY**, Rectangular Bakelite Case
2. **Model 23B**, Four Inch Diameter Bakelite Case
3. **Model 20B**, Three Inch Diameter Shielded Case

For use with I.S.A. Type Y, J, T, K or Chromel-Constantan Thermocouples.*



THE LEWIS ENGINEERING CO.
NAUGATUCK, CONNECTICUT

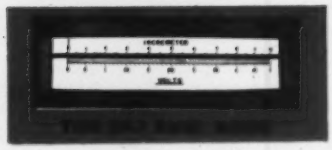
*Hoskins TM.

CIRCLE 2 ON READER-SERVICE CARD

THIS MAY SEEM LIKE A LOT OF SCALES FOR *ONE* INSTRUMENT...

INCREMETER
But-
THAT'S WHAT YOU GET
in the RADICALLY NEW
SENSITIVE RESEARCH
INCREMETER*
*By definition—A DIRECT READING DC ELECTRICAL INDICATING INSTRUMENT with an EFFECTIVE SCALE LENGTH OF 63 INCHES and an ACCURACY OF .05%.

The Model INCRE essentially consists of a differential instrument of "high comparison accuracy" and a stable "high accuracy" reference source. The instrument's actual scale length is 6.3", but this represents only 10% of its total effective scale length. Each 10% of its full scale range is selected by an incremental switch in effect creating a 90% scale suppression at all times. ***Ranges*** — single or multirange from 200 mv. full scale (lowest reading .2 mv.)



and 200 microamperes full scale (lowest reading .2 microamperes). ***Resolution*** — effectively 1,000 scale divisions over a 63" scale length. Each scale division has a value of .1%. ***Availability*** — portable or as a rack-mounted edgewise panel instrument. **The SRIC Differential "63" Incremeter** is a high resolution, *phenomenally* accurate measuring device with proven stability because it *is* an Electrical Indicating Instrument. **Diamond Pivoted *of course!***

Write for additional information on the *NEW* "INCREMETER".

SENSITIVE RESEARCH INSTRUMENT CORPORATION

CIRCLE 3 ON READER-SERVICE CARD

INSTRUMENTS AND CONTROL SYSTEMS

1961 EDITORIAL coverage will feature twelve basic phases of instrumentation, as reported on page 2061.

VOLUME 33, NUMBER 12, DECEMBER 1960

EDITORIAL

Preview of 1961 2061

FEATURE ARTICLES

Process Control Systems 2064

FRED D. MARTON—oscillating valve maintains constant heavy-slurry flow; hot-top drying oven system; computer control of vinyl chloride and acrylonitrile processes

The Plant Instrument Department 2067

FELIX E. DANDOIS—25 years ago we had no formal instrument department. Today we are doubling plant instrumentation every 10 years

Computer Storage Techniques 2070

G. A. OLIVER—first in a series of articles on data storage technology

Bidirectional Counting 2074

ROSS E. HUPP—bidirectional or add/subtract counters are finding general use in digital automation

Radioactivity-Controlled Time-Delay Circuits 2077

C. L. SMITH, P. J. KISATSKY—electronic time delay devices have been developed utilizing radioactivity-stabilized and controlled components

Tension in Industry 2081

DR. ERWIN J. SAXL—tension can cause change in a material due to physical deformation, stress hardening and narrowing of the material

Hottest-Point Seeker 2083

J. W. ADAMS—this memory system indicates the input line that has the highest signal level

High-Temperature X-Ray Diffractometer 2085

D. K. DAS—material phases and concentrations at elevated temperatures can be observed via x-ray analysis.

Timing Synchronization to 10^{-6} Second 2086

NBS system uses Loran technique

INSTRUMENTS AND CONTROL SYSTEMS

VOL. 33 NO. 10
DECEMBER, 1960

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Positioning by Magnetostriction **2102**

ARTHUR PARNES, CHARLES E. WITHAM—positioning by a constant-energy device rather than a constant-force device

The Journal of the Southern California Meter Association **2088**

Pneumatic Controllers by JOE N. KOVALY—basic mechanics of on-off, proportional, and integral control with pneumatic control devices.

The Simulation Council Newsletter **2091**

Eastern S/C Meeting of 16 May on Analog Computers in the Process Industries.

Gruet on Varistors
Drews on Optimization
Franks on Memory
Rubin on Statistical Studies

Simulation of Economic Systems **2100**

GEORGE S. GLINSKI—computers are ready and able to help economists. Are economists ready for this help?

OTHER REGULAR FEATURES

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New Applications 2022	Books 2057	Inquiry Card 2149
Stock Report 2026	New Instruments 2104	Product Index 2150
	New Literature 2138	

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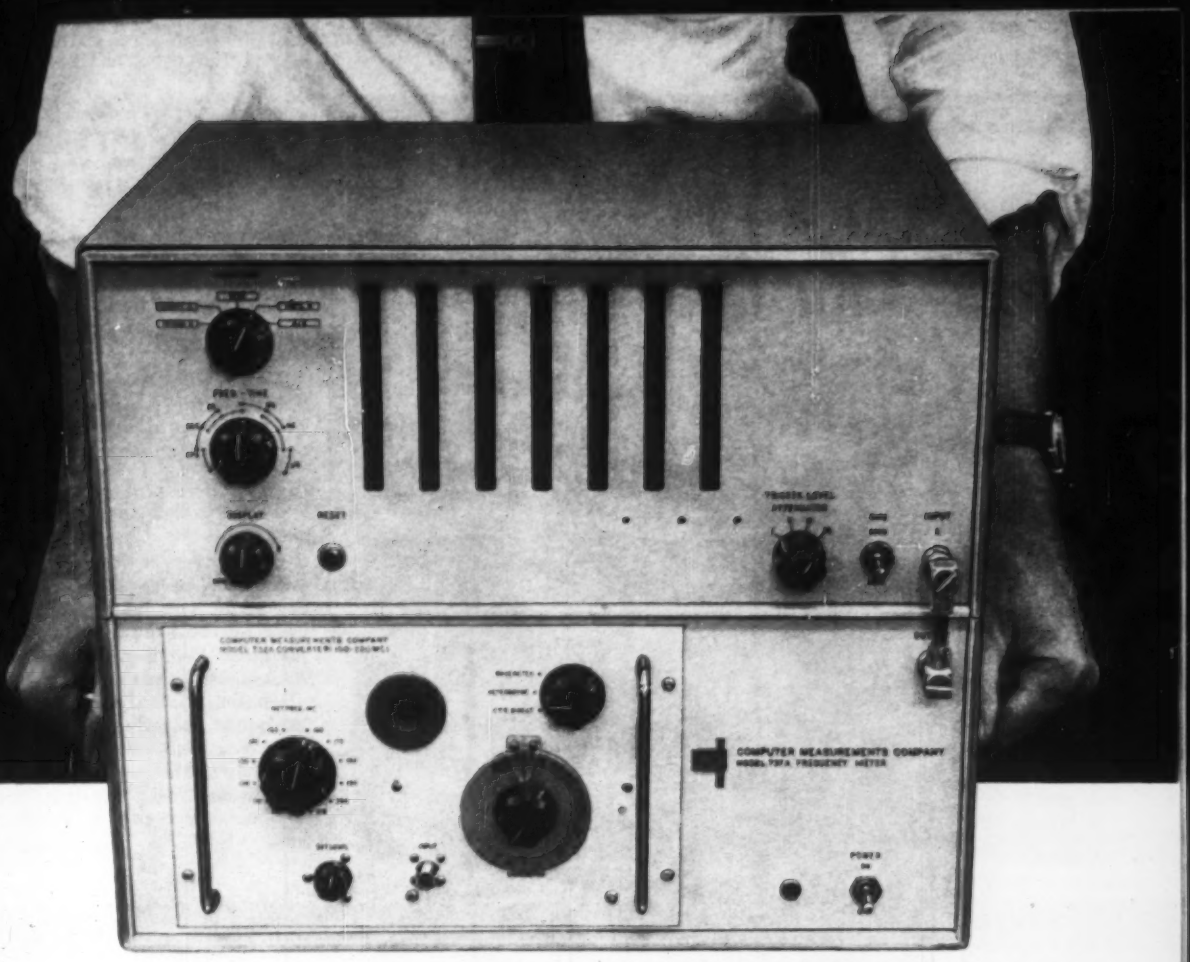


Model 737A shown with Model 732A Converter Plug-In

→ Measure frequency dc to 220 mc
→ Measure period to 0.1 microsecond
→ Measure time interval 0.1 microsecond to 10^7 seconds
→ Count dc to 10 mc

CMC, first with solid state reliability, announces the transistorized Model 737A frequency-period meter.

Here, combined in one compact package weighing a scant 53 pounds, are the functions of a high speed counter, frequency meter, and period meter. Sensibly priced at $2400, the Model 737A mates an all solid state counter with a plug-in vacuum tube heterodyne converter.

Only 14" high, 17" wide, and 13" deep, CMC's new Model 737A requires a mere 125 watts of power which in itself reduces operating temperatures and contributes to long trouble-free life. And except for the vacuum tubes, the new unit is unconditionally guaranteed for two years.

THREE PLUG-INS AVAILABLE

1. 10 mc to 100 mc frequency converter; 2. 100 mc to 220 mc frequency converter; 3. Solid state 0.1 microsecond to 10^7 second time interval section.

Converter plug-ins $250 each. Time interval plug-in $300.

FEATURES AND ADVANTAGES ✱ *Decade count down time base, frequency divider circuits never need adjustment.* ✱ *Automatic decimal point.* ✱ *Nixie readout available as standard option.* ✱ *Stability, 2 parts in 10^7 standard, 5 parts in 10^8 special.* ✱ *Accuracy, ±1 count ± oscillator stability.* ✱ *Sensitivity, 0.25 v rms.* ✱ *Standardize against WWV.* ✱ *Remote programming without special regard to cable length, type of cable, or impedance matching.* ✱ *Printer output to drive digital recording equipment, punches, inline readout and other data handling gear, $80 extra.*

NEW TECHNICAL BULLETIN TELLS ALL

Your nearby CMC engineering representative will be happy to provide you with full technical, sales, and delivery information and arrange a demonstration at your convenience. For a free copy of our new technical bulletin, please address Dept. 5512

CMC 36

Computer Measurements Co.
A Division of Pacific Industries
12970 Bradley Avenue, Sylmar, California
Phone: EMpire 7-2161

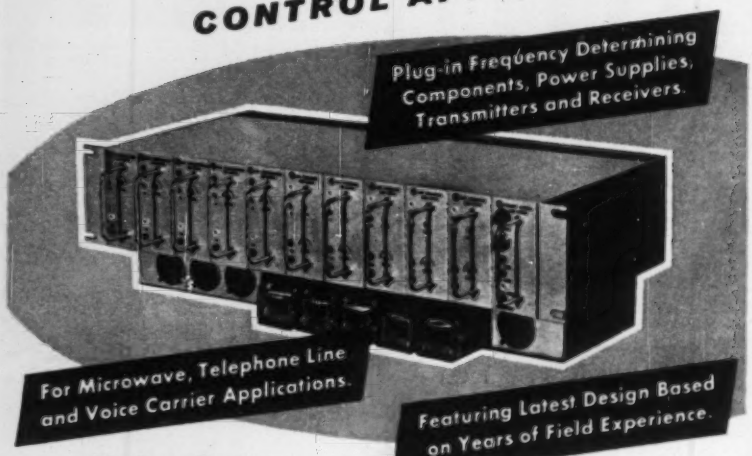
CIRCLE 4 ON READER-SERVICE CARD

REMOTE INSTRUMENTATION & CONTROL

Newest RFL Transistorized Series 2056

AM and FS Tones

for TELEMETERING and CONTROL APPLICATIONS


Plug-in Frequency Determining Components, Power Supplies, Transmitters and Receivers.
For Microwave, Telephone Line and Voice Carrier Applications.
Featuring Latest Design Based on Years of Field Experience.

Modern Design . . .
10 Transmitters or Receivers
and Power Supply in One Single Frame.

The 2056 Series of Audio tones features modern design utilizing plug-in card construction and provides equipment at a very minimum in cost with a maximum number of channels in a given space. For example, 10 AM transmitters or receivers and a common power supply are mounted in a single 3½ x 19" frame. Each channel is conveniently terminated with a terminal strip at the rear of the frame. Output relays are mounted on a bracket attached underneath the main chassis frame, each relay being located directly under its respective channel.

The channel frequency determining components are also of the plug-in type and are mounted directly on the channel plug-in assembly in AM units, and adjacent to plug-in assemblies on FS units. This type of design, of course, keeps spare parts requirements to a minimum, since all plug-in cards are common to all frequencies.

The 2056 Series of AM tones were designed to meet low speed tone signalling and control requirements when low noise lines and inherently low noise communication circuits as provided by microwave and voice carrier equipments are available for transmission.

The 2056 Series of FS tones are used when ultimate reliability and high speed keying is required. They can be used in circuits which are inherently noisy and which are subject to fading conditions.

The FS tones are available with either TWO or THREE frequency outputs. The former being employed in normal signalling and control circuits, whereas the latter is used in two-function single channel applications such as RAISE-OFF-LOWER, FORWARD-OFF-REVERSE.

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SEND FOR TECH. DATA — For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

CIRCLE 5 ON READER-SERVICE CARD

LETTERS TO THE EDITOR

Editor, I&CS:

Your October issue might be considered a "Handbook" more than a publication.

As a new subscriber, I am directly concerned with viscometers. I would like to have whatever has been prepared on that subject.

H. C. Von Rosenberg
Oklahoma City 10, Oklahoma

Our viscosity series, new in preparation, will cover all phases of viscosity. As you have noticed—each issue of I&CS is a "Handbook" in the sense that it covers one or two basic fields, in addition to its general coverage. Viscosity is coming up. Welcome aboard and let us know what you like and don't like about INSTRUMENTS AND CONTROL SYSTEMS. Comments from readers who actually read are doubly valuable.

Editor, I&CS:

I am interested in a statement Mr. McDonald made in the "Infrared Radiometry" article in the September 1960 issue of *Instruments and Control Systems*.

On page 1528 he speaks of hollow polished cones to condense the energy onto a smaller detector. We are interested in a project requiring a concentration of infrared for heating purposes, and are therefore wondering about the design of these cones.

John G. Attwood
Union Special Machine Co.
Chicago 10, Ill.

The author replies:

In answer to the question about usage of hollow polished light cones to condense infrared spot dimensions, I am sorry to report that little has been published on the subject. The basic reference is: "Cone Channel Condenser Optics," D. E. Williamson, J. Opt. Soc. Am. 42, pp 712-715 (October 1952). Another pertinent article may be: "Far Infrared Transmission through Metal Pipes", J. Opt. Soc. Amer. 48, pg. 531 (Aug. 1958).

All other references in my file are on classified equipments, such as air-to-air guided missiles. Sapphire rods also make good heat conductors (See:

J. Opt. Soc. Amer. 49, 75 (January '59). Remember in using these cones that heat emerges from the exit at all possible angles, hence the receiver must be placed close to the cone's end.

Richard K. McDonald

Editor, I&CS:

In your August, 1960, issue of *INSTRUMENTS AND CONTROL SYSTEMS*, your article on page 1280 of this issue entitled, "What Variables Can't You Measure Satisfactorily," was of particular interest to me.

The replies to your question under the categories of displacement, motion and stress appear to be directed to an area in which we have performed considerable study, and in turn have developed and are in the process of improving an extremely sensitive, remote, noncontacting type displacement indicator. We are therefore, very much interested in understanding the details associated with the problems which your readers have described.

A. L. Merlo
The Bendix Corporation
Research Laboratories Division

This letter will inform these men with these problems.

Editor, I&CS:

Since we are now in the process of setting up an entirely new and revised Standards and Instrument Service Section, the information in your *Handbook of Electrical Measurements* and various articles as they appear in your magazine are proving extremely valuable to us. We have set up a routing system for each copy of your magazine so that all concerned will have an opportunity to review these copies as they come in to our Library.

Our electrical instrument calibration and repair groups are split up into two different locations. One group serves an engineering facility and the other a manufacturing facility, each located intwo separate buildings. We would appreciate receiving one additional copy of this *Handbook of Electrical Measurements* so that each group would then have their own copy.

Otis F. Russell, Jr.
Minneapolis-Honeywell Regulator Co.
Boston Div.
Boston, Mass.

hays

RAMBLINGS ON INSTRUMENTATION

How I Made ONE MILLION DOLLARS In My Spare Time Selling Pressure Instruments

by Nicholas Sharpus
Celebrated Slavic Cha-Cha Dancer

(An unexpurgated translation)

Ever since my appearance on that late—late panel show called "Who's Awake?", people have been stopping me on the street and asking, "How could you, Mr. Sharpus, a celebrated Slavic cha-cha dancer with no scientific education, make one million dollars selling pressure instruments?"

I have persistently refused to answer these questions for one excellent reason: I don't speak English. Don't even understand it for that matter. Crazy language.

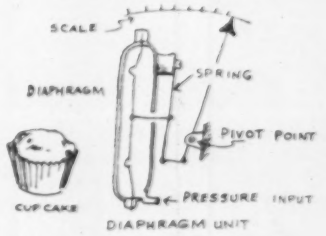
It is to put an end to all this gibberish that I have succumbed to innumerable requests (from my agent) to reveal the formula by which I scaled the heights of financial success.

Yes, it is true that I amassed my fortune selling pressure instruments in my spare time between dancing engagements at PTA meetings. (Boy, is that some dandy agent I got!)

But I want to caution any neophytes thinking of cleaning up big in pressure instrumentation that it's absolutely necessary to handle a *complete* line. For years I was on the verge of starvation, haggard and desperate, trying to peddle Ordinary pressure instruments, made by the Ordinary Instrument Company. No results, nothing. If I hadn't been able to swipe extra cupcakes (see sketch) at PTA meetings I never would have survived. But have you ever tried living on PTA cupcakes? This is living?

Then Fate intervened. Good old Joe Fate, that is. He introduced me to the Hays *complete* line of pressure instrumentation. Now, with Pressure Recorders, Indicators and Transmitters with ranges from 0.2" W.C. to 10,000 psi, I was a new man. No matter where I went, people pleaded with me to part with my Hays Direct Indicators with ranges from 0-0.2" to 0-10,000 psi and recorder from 0-0.2" to 0-120 psi. Others clamored for my Hays Transmitters, indicating and non-indicating with ranges from 0-0.2" to 0-10,000 psi. The Hays round dial, vertical scale or recording Electric Receivers sold like crazy. Yes, the cupcake days were over for old Nick, and I was sleeping indoors for a change.

As for the language barrier, I found I needed only two English words to close any low-pressure sale. While the prospect was poring over my sample case of twenty-seven instruments, I would say "Slack diaphragm" and the sale was clinched. Until recently I always thought "slack diaphragm" meant something like "Whom you got in da Series?". Now, however, I find it refers to a pressure sensing element originally



developed by a Hays engineer named Henry Diaphragm, a breakthrough in low pressure instrument standardization. They call it the Slack Diaphragm because it's . . . well, like slack, you know what I mean.

Now, one final request of you aspiring pressure instrument millionaires . . . write for the Hays literature on the subject and stop asking me those confusing questions! And by the way, my agent tells me I'm open for a few PTA bookings next year.

Editor's note: if you are included in the minuscule number of "Ramblings" fans, we'd be glad to send you a booklet of "The best of 'Ramblings' " culled from five years' output. It's well worth the 4¢ stamp it will cost you.

Paul A. Sprague
President

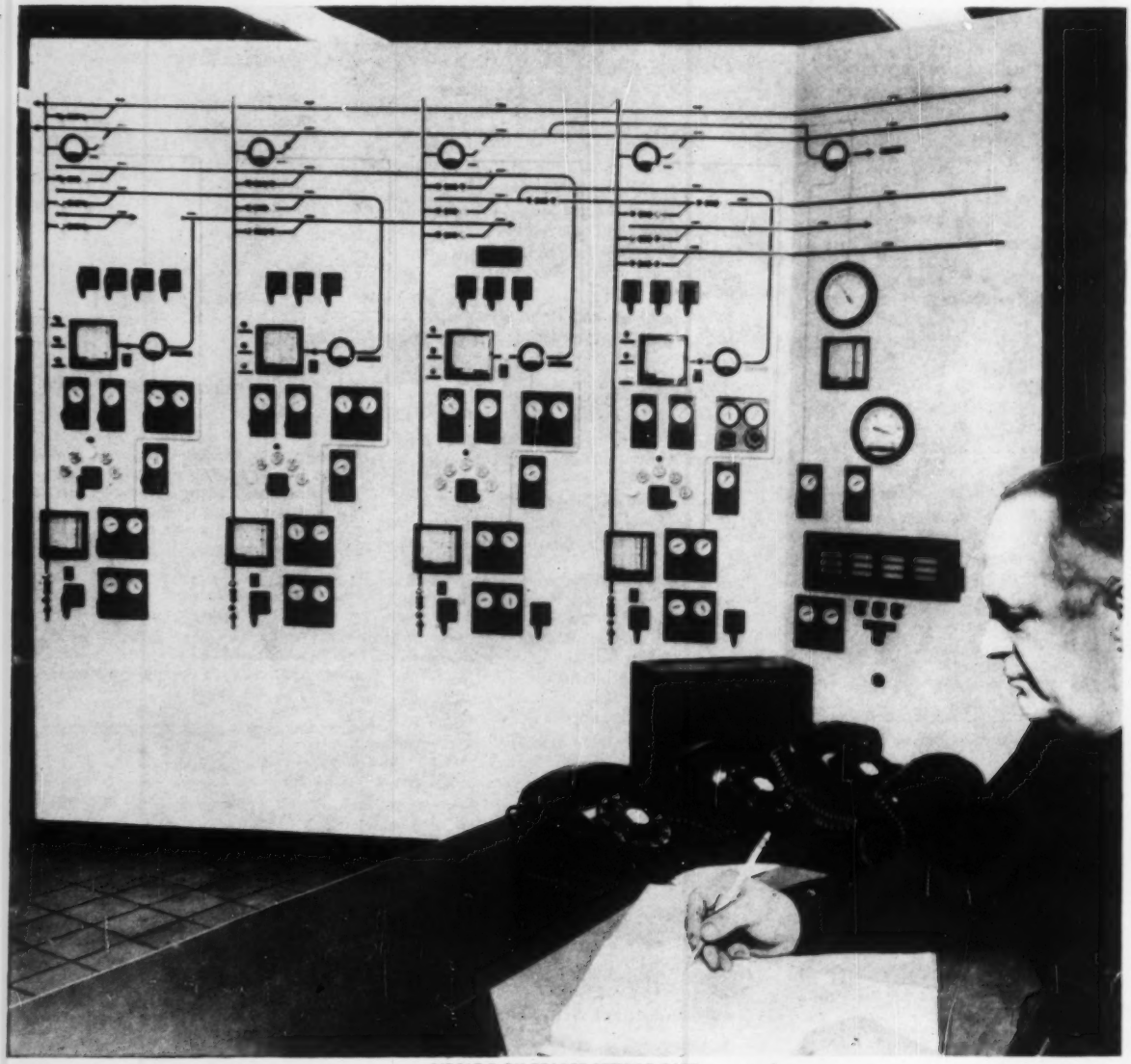
THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

CIRCLE 6 ON READER-SERVICE CARD

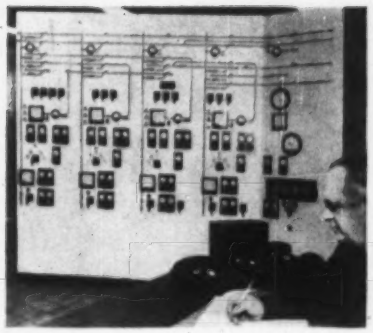
At U.S. Steel's Gary Works . . .

LOWER BLAST FURNACE BLOWING COSTS WITH HAGAN SPLIT-WIND CONTROL

Designed for future expansion, the graphic control panel is programmed in this manner: ■ No. 4 Turbo is blowing Furnace No. 11. Its excess capacity is "spilling-over" to augment the wind from No. 2 Turbo. ■ No. 2 Turbo is blowing Furnace Nos. 9 and 12, with the additional wind from the "spill-header." ■ No. 6 Turbo is blowing No. 10 Furnace.



CIRCLE 7 ON READER-SERVICE CARD



Today, split-wind blowing makes it possible for existing turbo-blower capacity to meet the constantly increasing wind requirements of rebuilt, enlarged blast furnaces and to do this at maximum possible efficiency.

A control system, to accomplish this objective, must provide centralized control for operator economy, and the flexibility needed to achieve high blowing efficiencies regardless of varying flow and pressure requirements.

In the system shown, installed at the Gary Works of U.S. Steel, three blowers supply blast air to four furnaces, with a fourth blower on operating standby. Normally, one turbo blows the furnace requiring the highest blast pressure. Excess wind passes into a spill-header and is used to augment the wind from the other active blowers.

The graphic control panel makes true centralized control possible by performing the following functions: shows the position of all control and shut-off valves—indicates and records the flow and pressure to each furnace—shows configuration of manifolding to blow the furnaces—provides communications between the control room and the cast house floor—records and indicates flow and pressure of each blower—provides remote manual operation of the shut-off valves—gives operators a means of changing furnace flow set point and manifold pressure.

For more information, write for Bulletin "Hagan Blast Furnace Control Systems."

HAGAN

CHEMICALS & CONTROLS, INC.

HAGAN DIVISIONS: CALGON CO.
HALL LABORATORIES • BRUNER CORP.

CIRCLE 7 ON READER-SERVICE CARD

I&CS LETTERS TO THE EDITOR

Editor, I&CS:

I object to scientists and "Emcees" who lead the public at large to believe—as was done on a nation-wide TV program Monday night (October 24th) that they are going to build a machine which can "think."

Granted that present-day computers can perform in spectacular ways, and much faster than can the humans who built them, it is, nevertheless, a fact that every machine ever built or now being considered will first have its "thinking" potential built into it by a mere human. To me, such "thinking" ability is not in its true sense the process of thinking.

My interepretation of the process of thinking may be a bit archaic, but I still believe the art of thinking does imply more than the ability to act after being properly programmed. It is unfortunate that the said program convinced a lot of people a machine is to be built to replace the human mind.

Your comments please.

Ray L. Miller
Indianapolis 8, Indiana

The scientists on that program pointed out that humans are indeed "programmed" in more ways than we know. It takes a lot of programming to arrange a whole nation of human beings so that they spend more on armaments for killing millions of other human beings than they do for feeding or educating or succoring those same human beings. Perhaps humans can learn from the computer.

Editor, I&CS:

It may interest you to know that your book *Digital Techniques for Computation and Control* is a prescribed reference for one of the subjects in the course in "Industrial Electronics" given at this college.

J. L. Ward,
Royal Melbourne Technical College
Victoria, Australia

5,000 psi MERCOID PRESSURE CONTROLS

OPERATING RANGE
500 to 5,000 psi.

External Adjustment
Sealed mercury contact
Visible calibrated dial
Visible on-off circuit
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minimum differential 450 psi.
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Weather-Proof
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CIRCLE 8 ON READER-SERVICE CARD

1 MODEL 28 AUTOMATIC SEND-RECEIVE SET—facilities for sending and receiving messages plus tape preparation and reading, receiving in tape, integrating tape and manual keyboarding. Incorporates major components of Model 28 line in single, compact console—a "complete station."

2 MODEL 28 SEND-RECEIVE PAGE PRINTER—for sending messages by direct keyboard, receiving incoming traffic, providing print-out facilities. Sprocket feed, horizontal tabulator and form positioning arrangements available. Both this unit and the automatic send-receive set are equipped with the "Stunt Box," a built-in control and switching device.

3 MODEL 28 TAPE READER—advanced reader-distributor design permits (1) reading of punched tape for serial transmission; (2) reading of punched tape for simultaneous output on parallel-wire basis; (3) translating of electrical impulses from an external parallel-wire source for serial transmission. Available for 5 or 6-level code.

4 MODEL 28 TAPE PUNCH—receives incoming electrical signals, punches a 5-level tape and prints-out data on the tape. Used for message relaying, combining data from several sources on a single tape, or providing punched tape as a by-product of send-receive operations for input to business machines.

CIRCLE 9 ON READER-SERVICE CARD

Teletype Model 28 Line...

standard units that offer flexibility, economy and reliability for message and data communications systems

The Teletype Model 28 line offers facilities to meet a wide variety of requirements in message and data communications equipment. It is an integrated line, designed on the modular principle, permitting flexibility in selection and interchange of components.

Speed is 10 characters per second for page units and typing tape punches—up to 20 characters per second for tape readers and non-typing tape punches. Page printers and tape punches can be adapted for parallel-wire input.

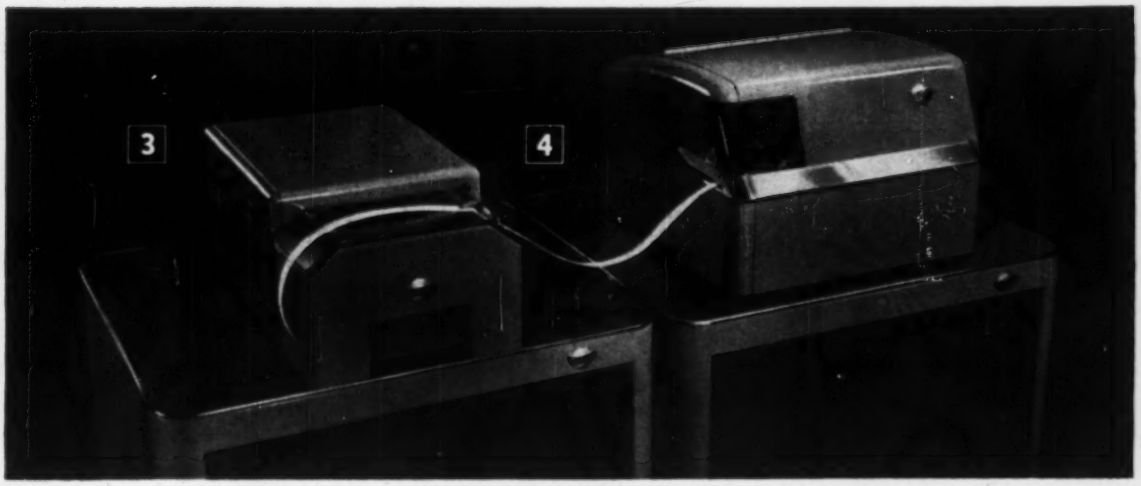
Exclusive with Teletype Model 28 page printers and automatic send-receive sets is the versatile "Stunt Box," a built-in mechanical memory device that is automatically activated by keyboard or line signals. The Stunt Box is used for internal control of "extra" features in the printer and external control of operations that can be activated electrically. It provides a simple, economical approach to station selection and many remote control problems.

The Teletype Model 28 line is specifically designed for continuous operation and very low maintenance. All-steel clutches and simple harmonic-design elements insure reliability and greatly reduce servicing needs. For example, the lubrication interval when operating at 10 characters per second is 6 months or 1,500 hours' operation, whichever occurs first.

Teletype Corporation manufactures this equipment for the Bell System and others who require the utmost reliability from their data communications facilities. Can be used with Data-Phone and other communications services.

More Information. Write for descriptive literature folder on Teletype Model 28 line to Dept. 27-M, 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.



CIRCLE 9 ON READER-SERVICE CARD

Before Buying Any Valve

ASK THESE QUESTIONS

1. Will It Perform More Effectively In The Service?
2. Where Will It Save Money?
3. How Practical Is The Design?

jamesbury

"Double-Seal"™

BALL VALVES*

As Versatile As Industry Itself!

PROVIDE THE RIGHT ANSWERS

1. The "Double-Seal" Ball Valve has PROVED more effective in handling a wider range of liquids and gases than any other valve.
2. The "Double-Seal" Ball Valve requires no lubrication. Special design permits valve stem to be removed for repacking while valve remains in line full-open or full-closed. Resulting savings on maintenance are significant.
3. The "Double-Seal" Ball Valve design is the original ball valve design engineered to give more control, full pipeline capacity and minimum friction loss.

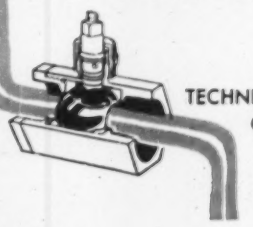
Widest Range of Sizes and Materials Available

METAL VALVES		PLASTIC VALVES	
TYPE	SIZES	TYPE	SIZES
Screwed End	¼" thru 3"	Screwed End	½" thru 3"
Flanged	½" thru 10"	Flanged	½" thru 4"

Jamesbury "Double-Seal" Ball Valves are available in Types 303, 316 and Alloy 20 Stainless Steels, Carbon Steel, Bronze, Ductile Iron, Aluminum and PVC. Other materials on special order.

Interchangeable seats and seals are available in "Teflon", Nylon, Buna-N, Neoprene, Hypalon and natural rubbers.

Pneumatic, Hydraulic and Electric Motor Operators to fit Remote Control Requirements.



COMPLETE TECHNICAL INFORMATION ON REQUEST

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JAMESBURY CORP., Worcester, Mass.

Distributors in Principal Cities

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CIRCLE 10 ON READER-SERVICE CARD

Computer-control systems market is $10 million in 1960, compared to $3 million in 1959, says Thompson-Ramo-Wooldridge, and will reach $30 million in 1961. Fifteen firms are competing in this field, including Daystrom Systems, General Electric, TRW (invested $10 million to date), IBM, Westinghouse, Foxboro-RCA, Philco-L&N, ISI, GPE (Royal Precision, Royal McBee, Libratrol), Autonetics, Bailey-Packard-Bell, Minneapolis-Honeywell, Ferranti.

Documentation (publishing research reports, journals, etc.) is growing problem, says W. Hutchinson, Standardization Div., Armed Forces Supply & Support Center. Military engineering documentation now costs $2 billion out of the $41 billion military budgets.

Between 50,000 and 100,000 technical journals, published in 60 languages, present more than 1 million papers annually.

Number of scientists and engineers in the electronics industry is being surveyed by Electronic Industries Association. J. Bridges, Director of Electronics, Office of the Secretary of Defense for Research & Engineering, estimates that there are 140,000 electronic engineers and scientists in the USA, with 110,000 in industry, but 80-90% working on defense-supported programs.

12 to 15 billion checks flow through the nation's 14,500 banks, and each is handled 5 to 7 times. Hence banking industry is watching all attempts at automation very closely.

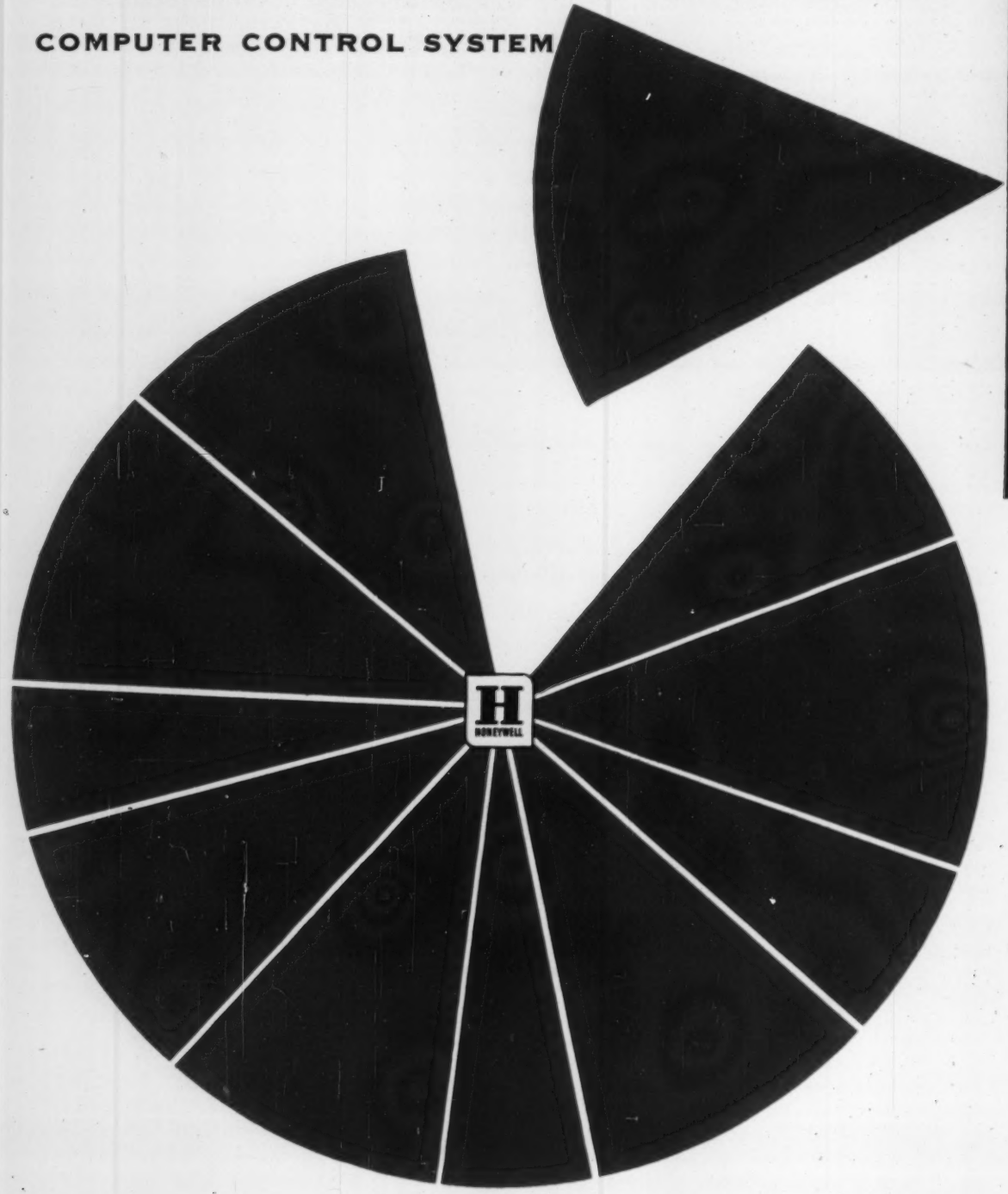
US particle acceleration program is expanding owing to Piore report, which advises government to step up its support from present $59 million per year to $135 million by 1963. Two new giants have been authorized by government—45,000-Mev electron linear accelerator at Stanford University (which will be two miles in length), and 12,500-Mev protron synchroton at AEC's Argonne Nat'l Lab, Chicago. Largest accelerator now in US is 6200-Mev bevatron at U of Cal. Under construction are (1) 25,000-Mev synchrotron at AEC's Brookhaven Nat'l Lab, (2) 30,000-Mev electron synchrotron by Princeton and U of Penna., (3) 6000-Mev electron synchrotron by Harvard-MIT. Fifteen accelerators are already in operation with energies above 200 Mev; four with energies above 1000 Mev.

Yearly output of engineering drawings for the military services amounts to more than 6 million annually. More than 50 million drawings are on file. More than 1 million of these are reproduced every year to meet defense requirements.

Chemical production and research facilities costing an estimated $1.657 billion will be constructed in the United States during 1960 and 1961, the Manufacturing Chemists' Association reports. Projects with a collective price tag of approximately $1.344 billion were completed in 1959. This brings total construction costs for the three-year survey period—1959-61—to an estimated $3.002 billion (all privately financed) as follows: General Inorganic Chemicals (22.8%) $686,219,000; General Organic Chemicals (22.5%) $674,508,000; Petrochemicals (15.2%) $454,536,000; Plastics and Resins (15%) $450,080,000; Laboratories (7.3%) $220,485,000; Fertilizer Chemicals (3.9%) $116,427,000; Synthetic Fibers (3.4%) $101,300,000; Synthetic Rubber (1.5%) $45,150,000; All Others (5.5%) $167,046,000.

NEW HONEYWELL 290 INDUSTRIAL DIGITAL COMPUTER

. . . HEART OF THE FIRST COMPLETELY INTEGRATED COMPUTER CONTROL SYSTEM



CIRCLE 11 ON READER-SERVICE CARD

Single-Source Responsibility. Now you can get the first truly complete computer control package produced by a single manufacturer. The new, all-solid-state Honeywell 290 Industrial Digital Computer rounds out Honeywell's broad line of instrumentation, and enables you to specify an all-Honeywell process control system. That means you're protected by single-source responsibility . . . from primary elements to final controls, from initial concept through maintenance.

High Speed plus Reliability. This new computer is the most powerful in its field. Typical operation rates: 8,000 additions, 1,250 multiplications, or 400 square root extractions per second. This high-speed computing of currently pertinent data gives you precise process control. Simplified programming adapts the computer easily to process changes. All-solid-state design and extensive system self-checks are engineered into every circuit and every unit of the computer.

Application Experience plus Computer Know-How. With the addition of the Honeywell 290 computer to the world's most extensive line of measuring and control equipment, Honeywell systems engineers now have the tools to implement all applications including those requiring computer control.

Take advantage of Honeywell's 75 years of experience in industrial process control. Get the advantage of having your entire system under Honeywell's overall responsibility.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

75th YEAR — PIONEERING THE FUTURE

Honeywell

First in Control

SINCE 1885

CIRCLE 11 ON READER-SERVICE CARD

AEROSPACE CORPORATION

are creating a climate conducive to significant scientific achievement

"Essentially, this corporation will be people—people of the highest quality. The United States Air Force recognizes that men of great scientific and technical competence can perform at their best only when they can exercise their initiative to the full under leadership which creates the climate for creativity. We expect Aerospace Corporation to provide that kind of environment."

SECRETARY OF THE AIR FORCE

Among those providing their leadership to this new non-profit public service corporation are: Dr. Ivan A. Getting, president; Allen F. Donovan, senior vice president, technical; Jack H. Irving, vice president and general manager, systems research and planning; Edward J. Barlow, vice president and general manager, engineering division; and Dr. Chalmers W. Sherwin, vice president and general manager, laboratories division.

These scientist/administrators are now selecting the scientists and engineers who will achieve the mission of Aerospace Corporation: concentrating the full resources of modern science and technology on rapidly achieving those advances in missile/space systems indispensable to the national security.

The functions of Aerospace Corporation include responsibility for: advanced systems analysis; research and experimentation; initial systems engineering; and general technical supervision of new systems through their critical phases, on behalf of the United States Air Force.

Aerospace Corporation is already engaged in a wide variety of specific systems projects and research programs—offering scientists and engineers the opportunity to exercise their full capabilities, on assignments of unusual scope, within a stimulating environment.

Immediate opportunities exist for:

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  Propulsion Systems
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Those capable of contributing in these and other areas are invited to direct their resumes to:

Mr. James M. Benning, Room 125
P.O. Box 95081, Los Angeles 45, Calif.

A new and vital force AEROSPACE CORPORATION *engaged in accelerating the advancement of space science and technology*

CIRCLE 12 ON READER-SERVICE CARD

Think what a waltz life would be after you installed Benson-Lehner's OSCAR K record reading system. No more needless drudgery in slowly reading, interpreting and transcribing trace records...why, you could romp through your record reading chores with this complete, compact system...and it's only a mere $4990. The OSCAR K can read paper trace records, transparent trace records, and translucent or opaque film records with an accuracy of plus or minus 0.1% of full scale. It takes records up to 12-1/2" wide and 500 ft. long, in either direction at a motorized variable speed. Output is to Benson-Lehner's Electrotyper or IBM Keypunch. Your record reading would not only go faster and more accurately, but at so much less cost. So why not make music together? Just ask us.

benson-lehner *Corporation. Write us at 11930 Olympic Boulevard, Los Angeles 64, California.*

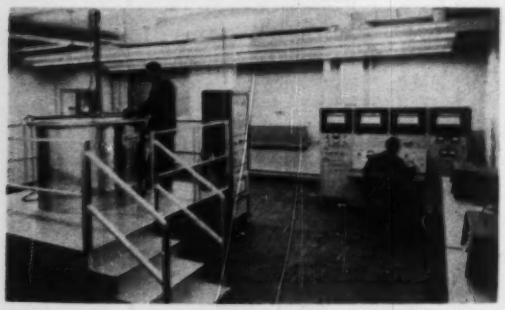
CIRCLE 13 ON READER-SERVICE CARD

ICS NEWS

Institute of Measurement Science

WASHINGTON, D. C.—An "Institute of Measurement Science" will be established at the School of Engineering, George Washington University in Washington, D. C., with the support of the National Bureau of Standards and The Martin Company of Baltimore, Maryland. First classes will begin in February, 1961 as part of the GWU regular curriculum. Several courses will be offered including a fundamental course in Metrology, a course on statistics as applied to measurement. Those specializing in Metrology will be required to take about 30% of all their courses in this subject. The Martin Company provided the initial funds of $10,000 which made the center possible. Master of Science, Bachelor of Science, and Doctorate of Science degrees will be offered by the center. George Washington University is one of the few universities which already offers some courses in Metrology and this led to increasing interest in the field, resulting in establishment of the Institute of Measurement Science.

MINNEAPOLIS-HONEYWELL, Industrial Systems Division, has built a large-scale data acquisition and processing system for the Bacchus, Utah, rocket propellant plant of Hercules Powder Co. The system can sample 10,000 items of data/sec, simultaneously measuring as many as 120 variables. It consists of six magnetic-tape transports for analog and two for digital data acquisition,



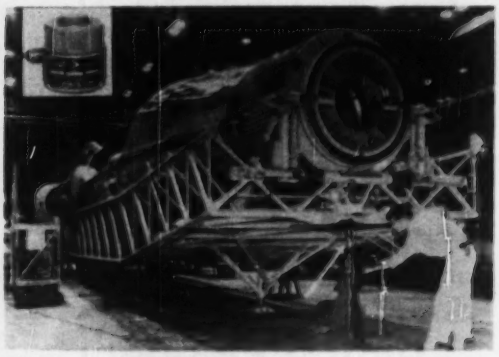
a transport for digital data transcription, three direct-writing oscillographs, and a wave analyzer with associate tape loop transport. It also included 120 AccuData amplifiers and conditioning equipment for strain-gage, thermocouple- and piezoelectric-transducers. (Minneapolis-Honeywell Regulator Co., Industrial Systems Div., Beltsville, Md.)

FOR MORE INFORMATION CIRCLE 151 ON READER-SERVICE CARD

THE CINCINNATI CHAPTER OF THE ISA will sponsor its biennial Ohio Valley Instrument-Automation-Electronics Exposition April 11 and 12, 1961 at the Cincinnati Gardens. A Symposium program as a companion project is now under negotiation, with participation of other technical societies anticipated. Address inquiries to Paul D. Fleming, General Chairman, 2512 Homestead Place, Westwood, Cincinnati, Ohio.

Weighing-in of Missiles by Load Cells

PITTSBURGH, PA.—In keeping tab on the weights of aircraft and missiles, "C and S" Precision Strain Gage Load Cells (shown in insert), manufactured by Revere Corp. of America, a subsidiary of Neptune Meter Co.,

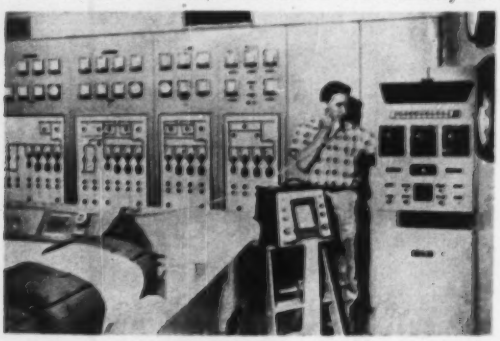


(P. O. Box 304, Wallingford, Conn.) are used. The small plunger-like top of the load cells must take high compressive loads and resultant high strain concentration and bending moment. A special cable connects the load cell with an electronic weighing kit which reads out weight to accuracies of 0.1%.

FOR MORE INFORMATION CIRCLE 153 ON READER-SERVICE CARD

Direct-Writing Recorders Check Coding Systems for Controlling Flow of Crude Oil

CLEVELAND, OHIO.—Shand & Jurs code systems for controlling, selecting and measuring storage tank levels at unattended pumping stations for moving crude oil from West Texas to Houston in Shell's Rancho pipe line system are checked out and maintained continuously to in-



sure proper operation at all times. Groups of pulsed signals which are employed to operate valves, switches, and other components at the substations are transmitted along telephone lines. Control system signals transmitted at a rate of 15 pulses/sec are recorded on two-channel direct-writing Brush Instruments Mark 11 recorders. Group selection, tank identification and tank level in feet and inches are recorded. With this method of testing any existing malfunction can be traced to either station or anywhere along the line where it may exist. More information can be had from Brush Instruments Div. of Clevite Corp., 37th and Perkins, Cleveland 14, Ohio.

FOR MORE INFORMATION CIRCLE 154 ON READER-SERVICE CARD

ASEA

builds world's largest load rated cell... 7 million pounds

Rated at 7,000,000 pounds, the largest capacity Pressductor, now being built in Sweden for a U. S. steel mill, measures 25"x24"...and is only 3" thick. Its output voltage is sufficient to drive an instrument or relay with no need for amplifier.

ASEA Pressductor's error of measurement, under normal conditions, is within ±1% of actual value between 10-100% nominal load. Under ideal conditions, even better accuracies may be obtained.

In service at many modern rolling mills, ASEA Pressductors are proving their suitability for the most difficult applications where dirt, dust and moisture problems exist. ASEA Pressductors withstand considerable overload without damage...are free of hysteresis (particularly important in automatic system regulation) ...resist lateral forces...offer interchangeability of units (no recalibration necessary)...and both calibration and performance are unaffected by age.

The superiority of ASEA Pressductors is now being proved in the following applications:

Measurement of:
rolling forces and strip tension in rolling mills ■ propulsion forces in ships ■ web tension in paper machines ■ column pressures in buildings

Weighing of:
coils in rolling mills ■ ore, etc., in hoppers ■ loads on cranes, hoists, elevators ■ charges in electric furnaces

Overload protection:
for transportation and handling equipment

Future planned applications include:
Measurement of:
rocket test stand thrust ■ tension of conveyor belts ■ torque in sluice gate hoists ■ pull in carrying cables and drag lines ■ drilling pressures for deep drilling

Weighing of:
trucks, railway cars, aircraft, etc., on loading platforms

Write for detailed descriptions of ASEA Pressductors and the advantages they offer to your specific job application.

U. S. Sales and Service: ASEA ELECTRIC, INC.
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CIRCLE 14 ON READER-SERVICE CARD

NEW APPLICATIONS

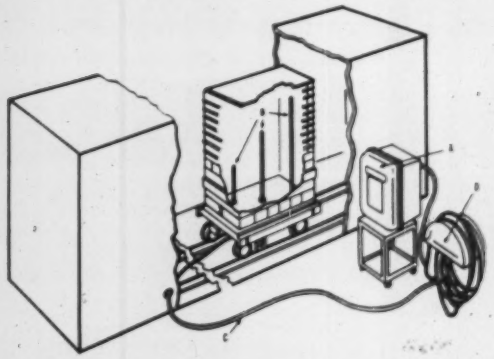
MINNEAPOLIS-HONEYWELL has designed and installed a sub-critical reactor and a reactor simulator in Northeastern University's nuclear laboratory. The simulator with its low level of fission permits students to gain experience in reactor operation and to study problems inherent in use of a "live" reactor.

HAGAN CHEMICALS & CONTROLS has furnished automatic control systems for the world's first adjustable-blade axial compressor for blast-furnace duty, to be installed at United States Steel's Edgar Thomson Works, in Braddock, Pa. The controls will govern weight flow from the compressor by adjustable stator blades. They also will protect the compressor against surge. (Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa.)

FOR MORE INFORMATION CIRCLE 155 ON READER-SERVICE CARD

Quality Control Helped by Checking Temp Gradients of Kilns

PHILADELPHIA, PA.—Important aids to quality control at the St. Marys, Pa., plant of the Stackpole Carbon Company are the refined methods for making frequent, continuous measurements of temperature profiles and gradients in their tunnel kilns. Products fired are "Ceremag" ferrite cores, ceramic magnets, and other relatively small, chemically-complex parts which require firing at

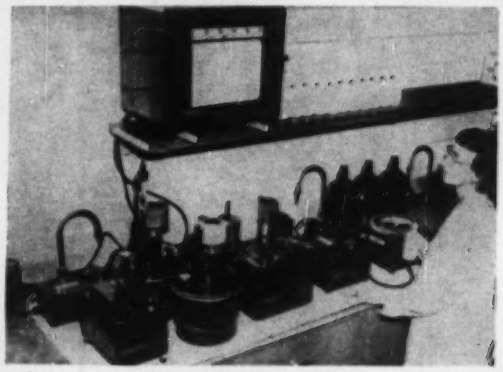


temperatures in the 2500°F range. A kiln may have as many as 8 zones of temperature, control of which employs Leeds & Northrup's Speedomax Type H DAT (Duration Adjusting Type) Controllers, with a Speedomax Type G multiple-point instrument for a monitor, and with kiln-atmosphere control by L&N magnetic Oxygen equipment. Platinum vs platinum-rhodium thermocouples in Fyrestan protection tubes are mounted on a kiln car, with their heads in the space below the sand seal. From the point directly below the car, the leads are protected by ⅜" tube of asbestos material, impregnated with Teflon RL-209 plastic. As the car moves, the tube snakes along a steel trough between the car rails, resisting not only the ambient temperature of about 800°F but the abrasion due to spilled sand, bits of ware and refractory in the trough. Various other protective materials have been used in this service, but Stackpole finds asbestos-Teflon very considerably the best to date. (Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia 44, Pa.)

FOR MORE INFORMATION CIRCLE 156 ON READER-SERVICE CARD

Automatic Chemical Analysis Aids Tobacco Research

CHAUNCEY, N. Y.—Chemical analyses performed in the analytical laboratory by the Research Center of Philip Morris Inc. have increased five-fold by use of an AutoAnalyzer, a product of Technicon Controls, Inc. The AutoAnalyzer is automating such analyses in tobacco



chemistry as reducing sugars (glucose), ketose sugars (fructose), total reducing substances in tobacco and smoke, and neutral and acidic reducing substances in smoke. Additional determinations, including chlorides, micro-glucose, and carbon dioxide are presently being considered. This robot chemist runs as many as 20, 40, or 60 tests/hour, as desired, without human interposition. (For more information contact Technicon Controls, Inc., Chauncey, N. Y.)

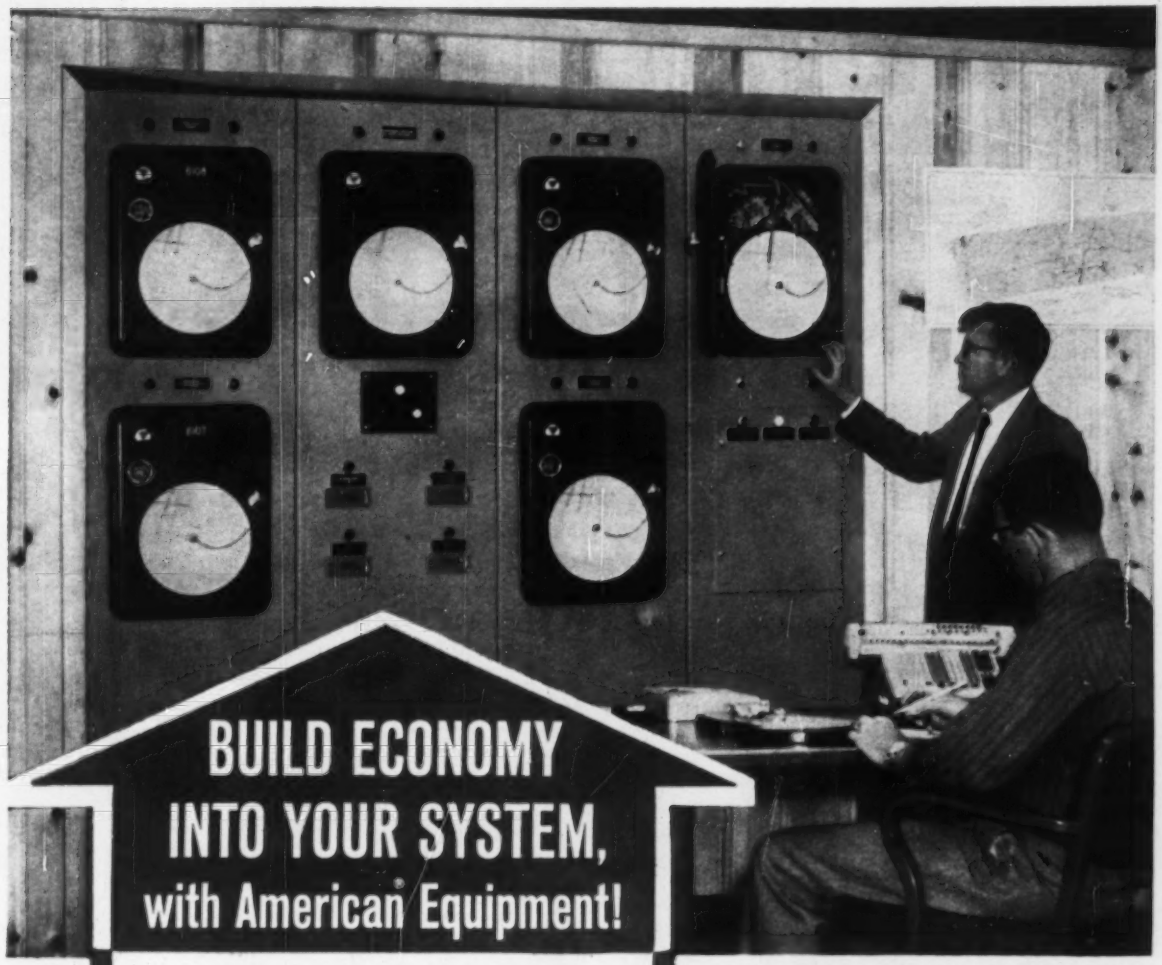
FOR MORE INFORMATION CIRCLE 157 ON READER-SERVICE CARD

BAILEY METER COMPANY's president, **P. S. Dickey,** is shown looking over a new Bailey 750 solid-state digital Information System recently shipped to U. S.

Steel, Fairless Works for continuously monitoring and logging temperatures on 16 soaking pit recuperators. (Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.)

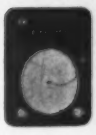
FOR MORE INFORMATION CIRCLE 158 ON READER-SERVICE CARD

BELL LABS recently unveiled its studies on one of the most efficient thermoelectric materials, silver antimony telluride ($AgSbTe_2$), at the International Conference on Semiconductors at Prague, Czechoslovakia. The material possesses a very low thermal conductivity, necessary in order to maintain a temperature differential between two ends of a device. Its thermoelectric figure of merit, "Z", has been measured as 1.75×10^{-3}/°C over a range of 200° to 500°C, which is the best yet observed for p-type thermoelements in this range.



BUILD ECONOMY INTO YOUR SYSTEM, with American® Equipment!

If you're already using American measurement and control equipment on your system — large or small — you know how it reduces manpower requirements and provides continuous operating economies. If you're not already saving with American equipment, ask your representative for full information. You'll be surprised to learn how little it costs to build sustained accuracy, dependability and long-term operating economies into your system.



TELEMETERING SYSTEMS — Designed to meet the individual requirements of any system.

CONTROLLERS — Series A-88 Controllers, Transmitters and Receivers for measurement and control of continuous process variables.

ORIFICE METERS — Dri-flo and mercury manometers in recording, indicating and integrating models — in a variety of working pressures and differential ranges.

CANNON PENS — Record up to a year without refilling — produce charts of maximum legibility — no blurring or smearing.

RELIANCE REGULATORS — For industrial, commercial and house service applications.

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INCORPORATED (ESTABLISHED 1836)

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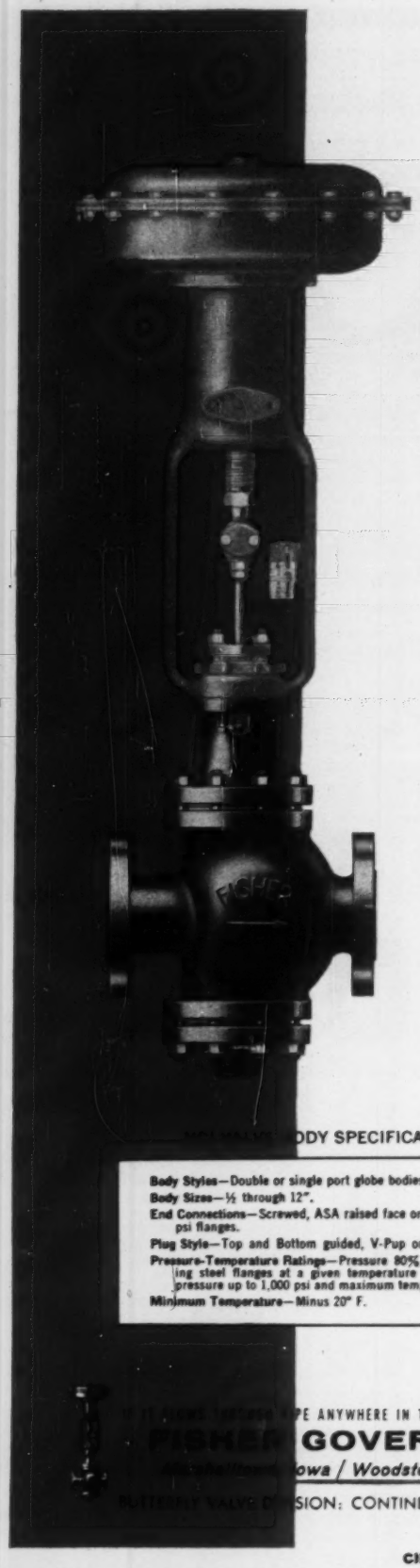
SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase, and Welded Steelcase Meters • American-Westcott Orifice Meters • Instruments • Reliance Regulators • Apparatus • Valves

CIRCLE 15 ON READER-SERVICE CARD



FISHER

NODULAR IRON CONTROL VALVES

save up to 23% over cast steel!

Fisher control valves are now available in high-strength Nodular (ductile) Iron bodies, that do the same job as steel valves . . . *for up to 23% less!*

Nodular Cast Iron has higher yield strength than steel. When overpressured, a Nodular Cast Iron valve will continue to operate satisfactorily without distortion, at a higher pressure, than a similar steel valve.

Ability to resist thermal shock compares favorably to steel. Nodular Cast Iron valves have been tested successfully at three times their rated pressure and their corrosion resistance is as good and generally better than cast iron or carbon steel.

Effective in temperature ranges of -20° F. to +650° F. and pressures up to 1,000 psi. Shock or impact characteristics are comparable to steel. Has more resistance to scaling in air at high temperatures than ordinary cast iron or plain carbon steel.

Would you like more information about this alloy?

SEND FOR TECHNICAL PAPER TM-5

DY SPECIFICATIONS

Body Styles—Double or single port globe bodies.
Body Sizes—½ through 12".
End Connections—Screwed, ASA raised face or RTJ 150 to 600 psi flanges.
Plug Style—Top and Bottom guided, V-Pup or Throttle Plug.
Pressure-Temperature Ratings—Pressure 80% of corresponding steel flanges at a given temperature with maximum pressure up to 1,000 psi and maximum temperature 650° F.
Minimum Temperature—Minus 20° F.

COMPARISON OF MECHANICAL PROPERTIES

	Cast Iron ASTM A126-B	Nodular Iron ASTM A395	Cast Steel ASTM A216-WCB
Tensile Strength, PSI	31,000 Min.	60,000 Min.	70,000 Min.
Yield Strength, PSI		45,000* Min.	36,000 Min.
Elongation, % in 2" Gage Length	NIL	15	22
Modulus of Elasticity, PSI	12—20x10⁶	24x10⁶	30x10⁶

*.2% Offset

E ANYWHERE IN THE WORLD. CHANCES ARE ITS CONTROLLED BY...

GOVERNOR COMPANY

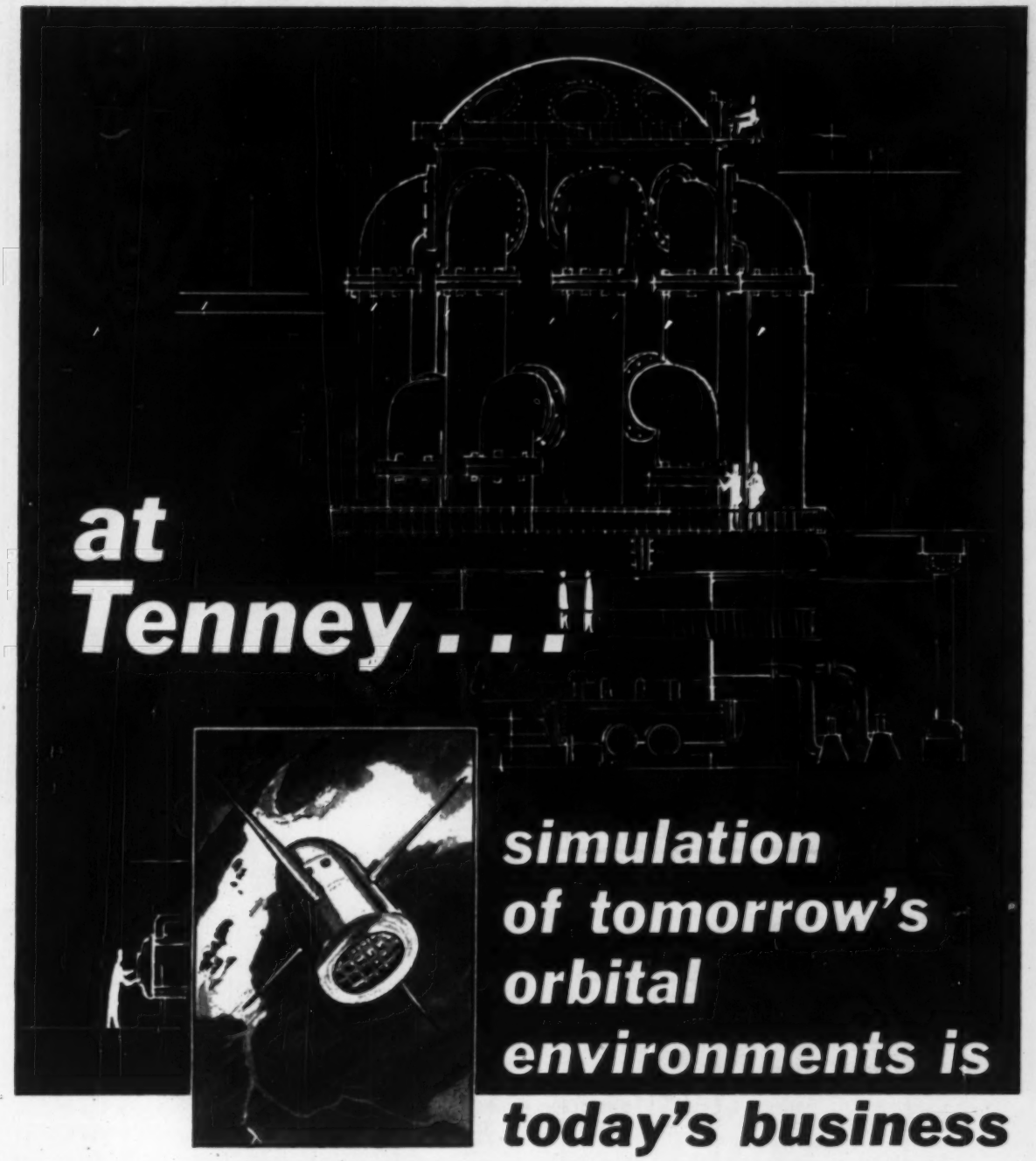
owa / Woodstock, Ontario / Rochester, England

SION: CONTINENTAL EQUIPMENT CO., CORAOPOLIS, PA.

FISHER

SINCE 1880

CIRCLE 16 ON READER-SERVICE CARD



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simulation of tomorrow's orbital environments is today's business

Tenney's research and development in the field of orbital simulation and hyper environments has been bringing high altitudes down to earth throughout the Space Age. No other company can match Tenney's deep engineering facilities and its successful experience with America's most important aerospace projects. Write today for further information about **your** project!

Tenney ENGINEERING, INC.

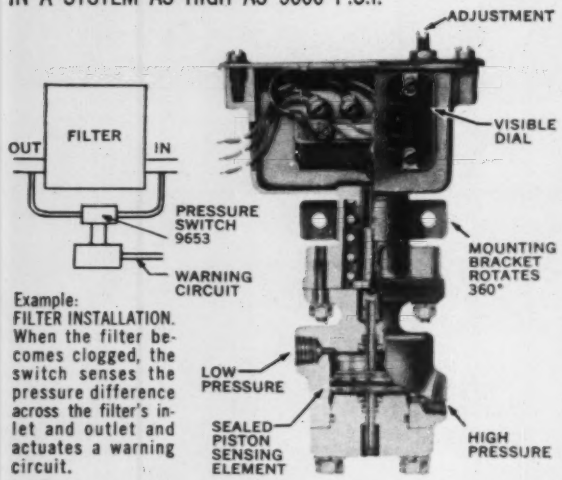
AEROSPACE DIVISION
1090 SPRINGFIELD ROAD, UNION, NEW JERSEY
PLANTS: UNION, N. J. AND WILMINGTON, N. C.

OLDEST AND LARGEST MANUFACTURER OF ENVIRONMENTAL EQUIPMENT

CIRCLE 17 ON READER-SERVICE CARD

NEW PRESSURE DIFFERENCE SWITCH

SENSES A LOW DIFFERENCE OF 10 P.S.I. EVEN IN A SYSTEM AS HIGH AS 5000 P.S.I.



Example: FILTER INSTALLATION. When the filter becomes clogged, the switch senses the pressure difference across the filter's inlet and outlet and actuates a warning circuit.

The new Model 9653 is constructed to sense a difference from 5 P.S.I. to 140 P.S.I. between two pressures. A sealed piston sensing element actuates an electric circuit on increasing or decreasing of a predetermined pressure difference. It is applicable to oil systems ranging from 50 P.S.I. to 6000 P.S.I. working pressure. A high proof pressure rating of 9000 P.S.I. is your protection against damage from surges and shock loads. Field setting is simplified by means of an external adjustment screw and visible dial.

WE BUILD IN	WE DON'T USE
RUGGEDNESS Can take surges— (High proof pressures) Continuous operation— (Millions of cycles) No sticking— (in dirty fluid)	 **LINKAGES & BEARINGS** Which wear quickly—(cause settings to drift and switch to fail).
LABOR & MATERIAL SAVINGS No return drain piping— (Sealed piston) Mounts where convenient (Operates in any position, Not sensitive to vibration)	 **UNSEALED PISTONS** Which add to your installation cost (return piping). Are critical to dirt—(pistons get stuck).

Ask for new pressure switch handbook and catalog '59-'60

PRESSURE SWITCH DIVISION

Barksdale valves

8125 ALCOA AVENUE, LOS ANGELES 58, CALIFORNIA

CIRCLE 18 ON READER-SERVICE CARD

IOS STOCK REPORT

Further information may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

AMERICAN STOCK EXCHANGE

PRICE RANGE 1960 THRU NOVEMBER 16, 1960

	High	Low	Price As Of 11/18/60
American Meter	52	39	41
Barry Wright Corp.	25 1/2	13 5/8	14 3/4
Belock Instruments	25 3/8	13 1/8	17 5/8
Benrus Watch	8 7/8	5 3/8	7 1/8
Breese Corp.	8 5/8	4 1/4	4 3/8
Burnell & Co.	9	6 1/8	7
Clark Controller	23 5/8	15 1/2	16 1/2
Clarostat Mfg.	16 3/8	9 7/8	12 1/4
Clary Corp.	11 1/2	6 3/4	8 1/4
Cubic Corp.	69	39 5/8	50 1/8
Dynamics Corp. of Amer.	13 3/4	6 5/8	8 1/4
El-Tronics	4	1 1/8	4
Electronics Corp. of Amer.	19 1/2	8 1/8	9 3/4
Fairchild Camera & Instrument	201 3/4	110 1/4	160
Giannini Controls	68 3/4	39	50 1/2
Globe Union	34 3/4	20 5/8	23 1/2
Hazeltine Corp.	31 1/2	20	23 3/8
Loral-Electronics	105 3/4	34 5/8	82
National Research	23 1/8	13 1/8	16 1/4
New Haven Clock	2 7/8	1 1/4	1 1/4
Nuclear Corp. of Amer.	5 1/8	2 1/8	3 1/2
Philips Electronics, Inc.	47 3/8	31 1/2	35
Pneumatic Scale	59 3/4	35	36
Polarad Electronics (new)	36 5/8	17	19 3/4
Servo Corp. of Amer.	24 1/2	9 1/4	11 1/2
Servomechanisms	16	7 1/2	8 3/8
Statham Instruments Inc.	40 1/4	25 3/4	28 1/2
Textron Electronics	18 3/4	8 5/8	9 3/8
Victoreen Instrument Co.	17 1/2	9 3/4	13
Waltham Prec. Instr. Co.	3 1/2	1 7/8	2

These Prices and price ranges are given as printed in the Wall Street Journal.

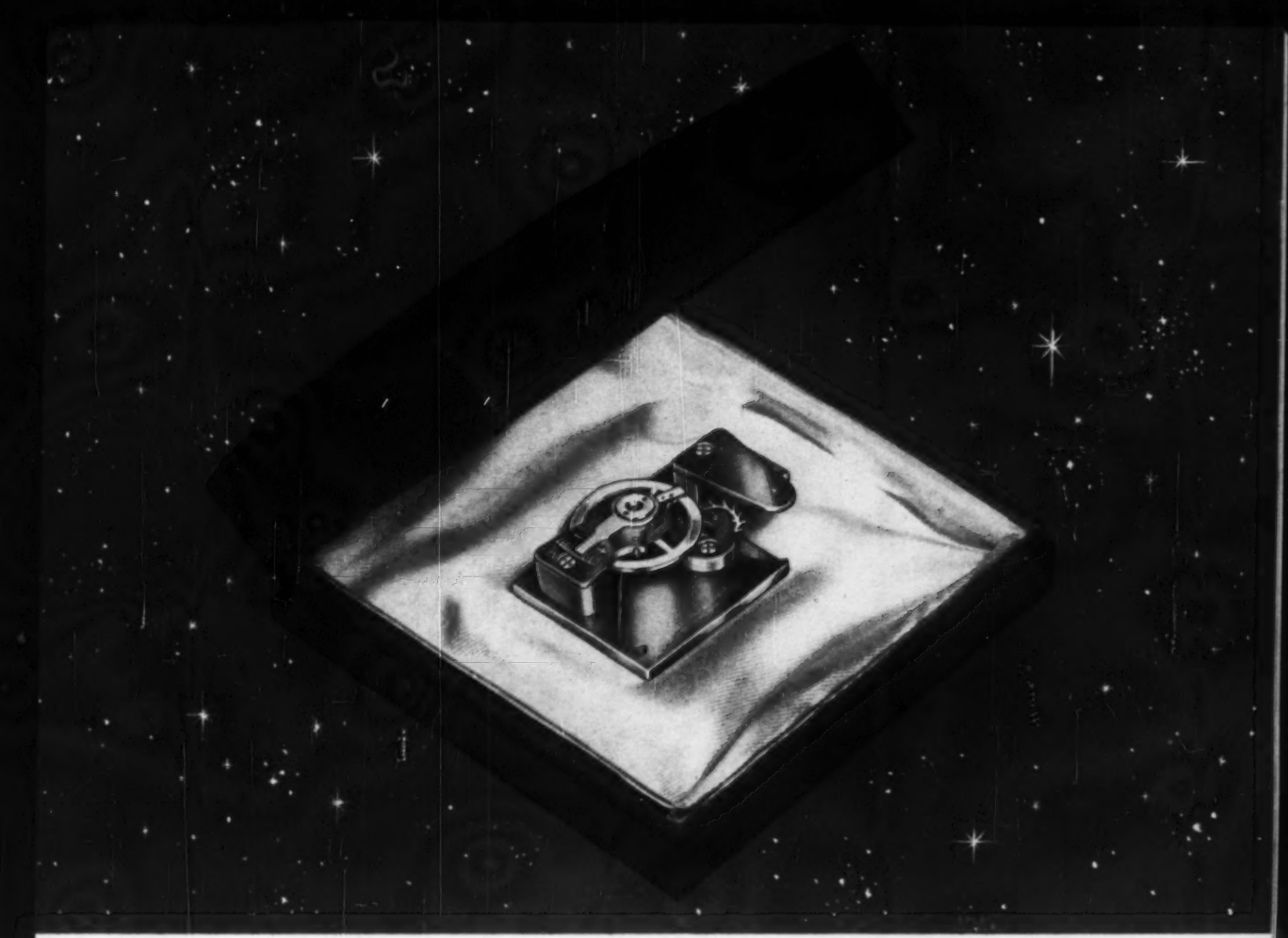
Barry Controls merged with Wright Line Inc., new name is Barry Wright Corp.

NEW YORK STOCK EXCHANGE

PRICE RANGE FOR 1960 THRU NOVEMBER 16, 1960

	High	Low	Price As Of 11/18/60
ACF Industries	52	35 1/8	38 1/2
Aeroquip Corp.	40 5/8	23	24 1/2
Allis Chalmers	40	22	24 3/8
American Chain & Cable	51 3/4	40 1/4	42 3/4
Amer. Mach. & Foundry	74 3/4	49 1/2	72 1/2
Amer. Mach. & Metals	58 1/4	31 3/4	35
American Optical	67	43 1/4	54 1/2
Amer. Tel. & Tel.	97 5/8	78 7/8	93 5/8
Ampex Corp.	42 1/4	19 1/2	23 1/8
Arc Equipment	23 7/8	19	20
Bausch & Lomb Optical	58 7/8	34 1/2	40
Beckman Instruments	103 3/4	62 1/2	85 1/4
Bell & Howell	57 1/2	37 5/8	43 5/8
Bendix Aviation	74 1/2	56 1/4	64 1/2
Boeing Airplane	36 1/4	23	35
Bullard	17 7/8	10 1/2	12 1/2
Bulova Watch	23 3/4	14 1/8	17 7/8
Burroughs	40 3/8	28	29 1/8
Carborundum	49 7/8	29 1/4	43 3/4
Cinn. Milling Machine	38 1/2	26 1/2	36 1/8
Clevite	72 1/2	42	58 1/8
Columbia Broadcasting Sys.	45 1/4	26 5/8	29 3/8
Consol. Electronics	60 3/4	32 1/4	46 3/4
Corning Glass	186	126	171 1/4
Curtiss Wright	31 1/8	16	16 5/8
Cutler-Hammer	96	67 1/4	78
Daystrom	49 3/8	27 1/2	32
Douglas Aircraft	42 3/8	27	31 3/4
Eastman Kodak	136 1/4	94	108 1/4
Eaton Mfg.	46 7/8	28 1/2	29 3/8
Electric Auto-Lite	54 1/2	44 1/2	47
Elgin Watch	19 1/8	10 1/2	12 1/8
Emerson Electric (new)	50	33	47 3/8
Engelhard Industries	23	17 5/8	18 5/8
Food Mach. & Chem.	58 1/8	44 1/2	53 1/8
Garrett	58 1/4	42 1/8	54 7/8
General Controls	29 5/8	15 3/4	22 1/4
General Dynamics	53 3/8	33 1/2	39 3/4
General Electric	99 7/8	70 1/4	78 3/8
General Instruments	50 3/8	22 1/2	37 7/8
General Mills	31 7/8	23 7/8	29 1/8
Gen. Precision Equip.	66 5/8	43 1/2	51 3/4
Gen. Railway Signal	36 7/8	23 1/4	29 7/8
Gen. Tel. & Elect. (new)	34 1/8	23 3/4	27 1/8
General Time (new)	33 1/8	12 1/2	14 3/4
General Tire & Rubber	81 3/8	41 5/8	52 1/2
International Bus. Mach.	551	407 1/4	541
International Resistance	41 5/8	18 1/4	28 1/2
Internat'l. Tel. & Tel.	46 3/4	32	40 7/8
I-T-E Circuit Breaker	44 1/4	18 1/8	18 1/4
Lear Inc.	23 1/2	13 5/8	18
Litton Industries	96	57 5/8	83 1/4
Lockheed Aircraft	32 7/8	18 5/8	26 3/4
Magnavox	55	31 3/4	42 1/4
Mallory	50 1/4	33	38 5/8
Minneapolis-Honeywell	178 3/4	123 5/8	135
Minnesota Mining & Mfg.	88	60	68 7/8
Motorola (new)	98	60 1/2	68
National Acme	54 3/4	40	47 1/2
National Cash Register	70 7/8	49 7/8	56 5/8

Continued on page 2029



This "jeweled" escapement brings you fine watch quality in chart drives

See how easy it is to convert to seven different rotation rates

The main arbor on the basic chart drive has a rotation rate of seven days. Economical snap on turrets convert this rate to 8 day, 15 day, 16 day, 24 day, 30 day, 31 day and 24 hour rotation. No tools are required and you can even change chart rotation without removing the drive from the instrument.

Now, for the first time you get the extra value of a jeweled movement. This superior construction makes Rockwell chart drives more accurate and sensitive than ordinary chart drives. It requires less power to drive and is extremely durable since there are seven hard jeweled surfaces to overcome friction and wear.

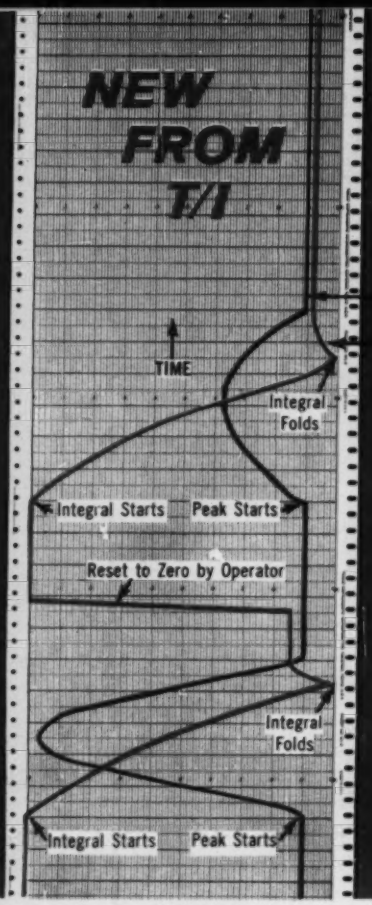
You can use these jeweled movement chart drives *with profit* to power all your recording instruments. They will adapt into practically any instrument case. Speed changing turrets (see left) permit varying rotation rates at will. Write for bulletin. Rockwell Manufacturing Company, Dept. 58-M, Pittsburgh 8, Pa. In Canada, Rockwell Manufacturing Company of Canada, Ltd., P.O. Box 420, Guelph, Ontario.

JEWELED CHART DRIVES

another fine product by

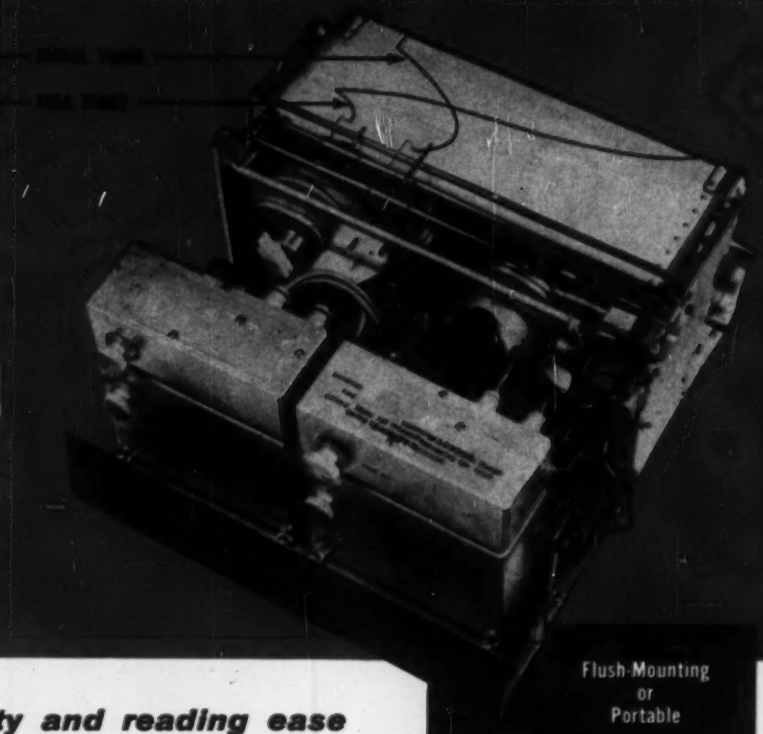
ROCKWELL

CIRCLE 19 ON READER-SERVICE CARD



servo/riter

INTEGRATING RECORDER



More speed, flexibility and reading ease than any other integrating recorder

Accurate, quantitative analysis of *any variable* that depends on the precise measurement and integration of the curve may be obtained with the TI Integrating Recorder. The integrator channel is installed as a second channel in a standard wide-grid, single-channel *servo/riter* recorder. It consists of a special potentiometer-amplifier-servo arrangement and activates an overlapping "area trace" automatically and simultaneously with the signal trace.

Three different maximum count rates are readily obtained through an adjustable gear system up to a maximum of 40,000 area counts per minute. The counting rate linearity is ± 0.5% of full scale.

Note that the integrating signal utilizes the full chart scale to provide faster, easier reading. Traverse of the full scale represents 1,000 counts. If the integral exceeds 1,000 counts, the integral "folds" and completes its excursion in the opposite direction. You may reset the pen to either margin between each peak or at the start of each integration for easier interpretation. The integrating circuit may be set to any assumed zero point in the span of the recorder signal.

The Integrator Recorder is offered with either portable or flush-mounting *servo/riter* recorders. Or, the Integrator Unit may be factory installed in your existing wide or dual chart *servo/riter* recorder. In fact, many flexible arrangements are possible . . . let TI's recorder engineers work with you on specific applications.

*A Trademark of Texas Instruments

Write for complete information . . .

INSTRUMENTATION GROUP OF

TEXAS INSTRUMENTS
INCORPORATED
GEOSCIENCES & INSTRUMENTATION DIVISION
3609 BUFFALO SPEEDWAY • HOUSTON 6, TEXAS

CIRCLE 20 ON READER-SERVICE CARD

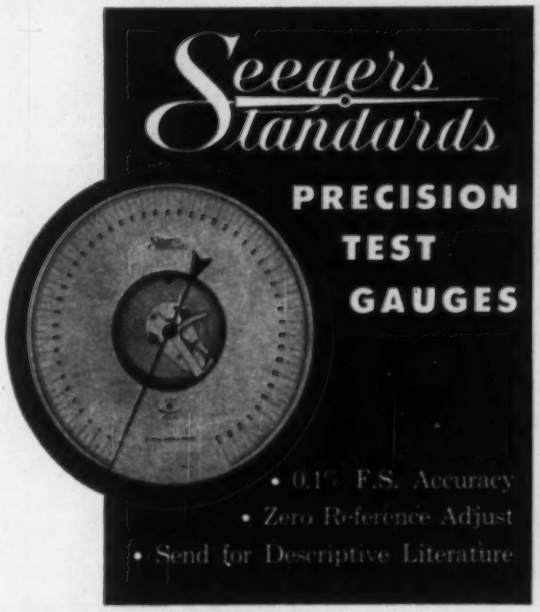
Continued from page 2026

Neptune Meter	34	3/8	34	27	1/4
North American Aviation	45	1/4	29	5/8	44	1/8
Northrop Aircraft	43	3/8	24	3/4	43	1/4
Otis Elevator	58	1/2	36	3/4	55	3/8
Philco Corp.	38	1/4	17	1/4	18	1/2
Radio Corp. of America	78	3/8	46	1/2	55	
Raytheon Mfg.	53	3/8	30	1/4	34	3/8
Reliance Electric	60	5/8	44		45	1/2
Rheem Mfg.	28	7/8	12		14	3/8
Robertshaw Fulton	55		33	1/4	35	3/4
Royal Mc Bee	21	3/8	11	7/8	12	7/8
Sangamo Electric	21	1/2	13	1/2	14	
Siegler Corp.	43		23	5/8	27	5/8
Sperry Rand	26	1/4	18	3/8	18	3/4
Square D	37	7/8	25	1/2	30	1/8
Standard Kollsman	30	1/2	12	5/8	21	1/8
Starrett (L.S.)	20		16		18	
Stewart-Warner	33	1/2	23		24	1/2
Telautograph	24	1/2	6	7/8	16	3/8
Texas Instruments	256	1/4	148	1/4	181	1/2
Thompson-Ramo-Wooldridge	47	1/2	46	7/8	63	7/8
Tung-Sol Electric	40	1/2	28		29	1/2
Underwood Corp.	57		34	3/4	46	
Union Carbide Corp.	148	1/2	104	1/2	120	1/2
United Shoe Machinery	44	3/8	50		55	3/4
Varian Associates	67	1/2	38	1/8	46	
Wallace & Tiernan	49	1/4	41		55	1/2
Western Union	57		38	1/4	39	5/8
Westinghouse Air Brake	32	5/8	21	1/8	22	1/8
Westinghouse Electric	65		45		50	
Worthington Corp.	66		41	1/2	45	3/4

These prices and price ranges are given as printed in the Wall Street Journal.

OVER THE COUNTER

	Quotation As of November 16, 1960 Bid		Asked	
Aerovox Corp.	7	1/2	8	1/2
Argus Corp.	29	3/4	30	1/2
Black Sivalls & Bryson Inc.	12	3/8	14	
Computer Systems	9	1/2	11	
Ritel Mc Cullough	14	3/4	15	3/4
Electro Instruments	20		22	
Electronics Associates	25		26	1/2
Erie Resistor Corporation	8	3/8	9	1/4
Fisher Governor Co.	17	3/4	18	1/2
Foxboro Company (New)	44		46	1/2
Hagan Chemicals & Controls	40		42	
Industro Transistor	5	1/4	6	3/8
Liquidometer Corp.	9	1/2	10	1/4
W. L. Maxson	7	5/8	8	1/4
Penn Controls	19		20	1/2
Speer Carbon, Inc.	19	1/2	21	
Sprague Electric	42	1/2	44	1/2
Taylor Instruments (new)	33		34	1/2
Telechrome Mfg. Corp.	10		11	1/4
Telecomputing Corp.	6	5/8	7	3/8
Vitro Corp. of Amer.	10		10	5/8



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INSTRUMENT COMPANY, INC.
501 West Main Street Barrington, Illinois

Look to Seegers Standards the World's Finest

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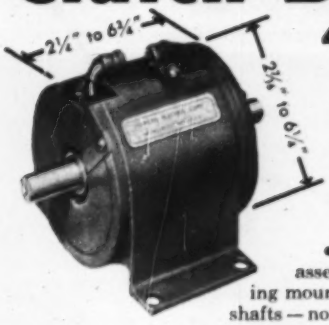
NEW Stearns
miniature
electro-magnetic disc
Clutch-Brakes



4 SIZES

- MODEL 2.2 SMCB 8-lb-in. Torque
- MODEL 3 SMCB 60 lb-in. Torque
- MODEL 5 SMCB 240 lb-in. Torque
- MODEL 5.5 SMCB 540 lb-in. Torque

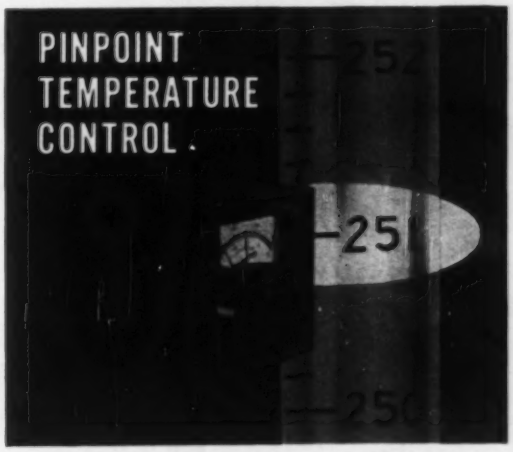
• Shipped completely assembled with ball bearing mounted drive and driven shafts — no alignment problems.

- Foot-mounted for fast, easy installation—anywhere.
- Any voltage up to and including 90 VDCW.
- *Request Bulletin No. 504-F for complete data.*

Stearns ELECTRIC CORPORATION
120 North Broadway
MILWAUKEE 2, WISCONSIN
Phone: BRoadway 2-1100

The COMPLETE LINE of CLUTCHES . . . BRAKES . . . CLUTCH-BRAKES

CIRCLE 21 ON READER-SERVICE CARD



Temperature controlled by Simplytrol is kept within ± 1°F. of set-point. Simplytrol's special time-proportioning circuit *anticipates* temperature build-ups and *amount* of deviation from the control point. It modifies the heat cycle accordingly . . . before wide temperature fluctuations can occur.

Yet, this is a surprisingly simple device. No amplifying circuits. No vacuum tubes. The A.P.I. meter-relay—tested for more than ten-million operations, sensitive enough to work directly from a thermocouple—permits it to function with great precision, free of drift or distortion.

You'll find all Simplytrol models, in thirty ranges from —400°F. to 3000°F., described in Bulletin 108.

Write for your copy

api **ASSEMBLY PRODUCTS INC.**
Chesterland 10, Ohio

CIRCLE 23 ON READER-SERVICE CARD

ACCURATE Remote Measurement

Plug this portable, self contained unit into any 110 volt, 60 cps outlet. This is *all you need* to accurately measure any displacements in ranges from ½ inch to 10 feet; from any distance up to 1000 feet. The system is built on the null balance principle. Since it contains no vacuum tubes, it is capable of operation for years without re-calibration or loss of accuracy.

FEATURES

Stroke: ½" up to 10 feet.

Accuracy: ± .3%.

Recording: Provides D.C. output for control and for recording displacements down to .0005 inch.

Package: Self contained; no added instrumentation required.

TRANSDUCERS
linear displacement • angular position • velocity • torque • force • pressure

VALVES
Differential relief, solenoid and priority valves. Flow and pressure regulators. Reservoirs and accumulators.

EXPECT MORE FROM **VINSON SYSTEMS**

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Your inquiry will receive an immediate reply from engineers experienced in the design and application of transducers and valves for the solution of measurement and control problems.

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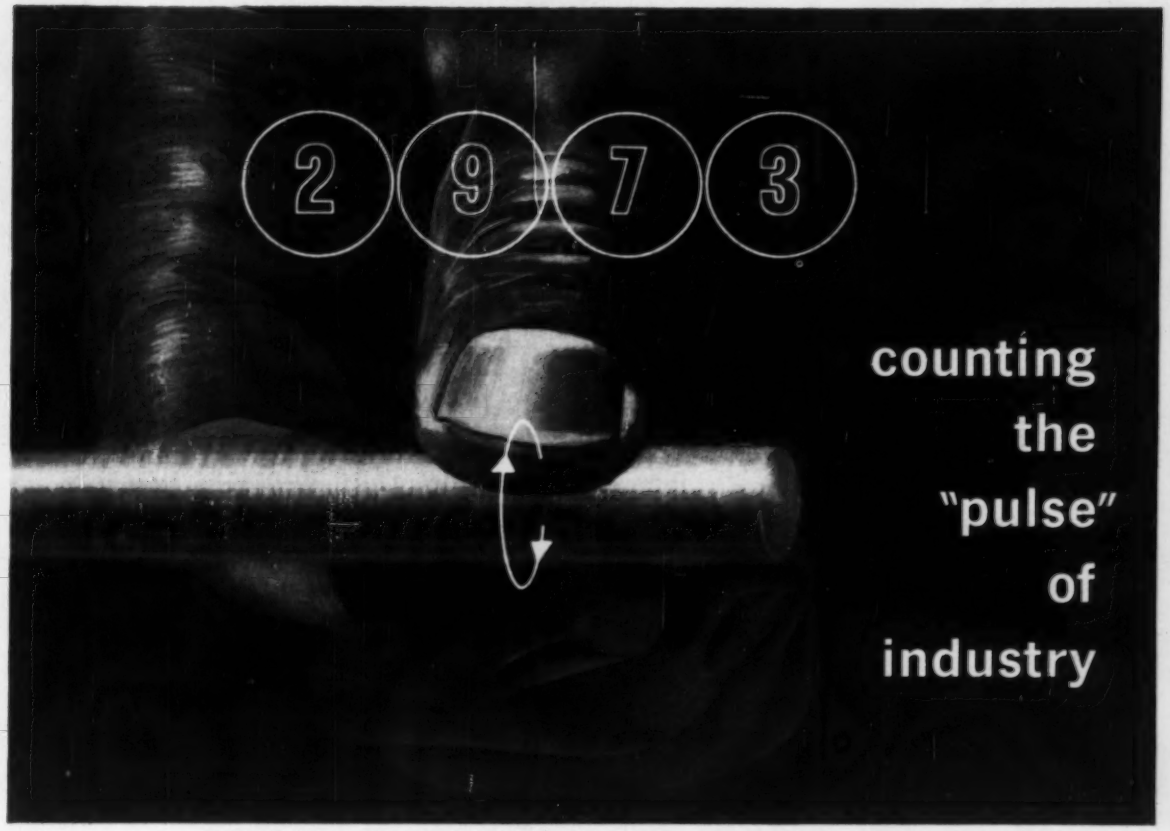
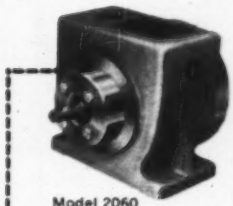


...through MERIAM·ILS electronic speed indicating systems



Model 2060
Explosion-proof
Tachometer Pickup.
U. L. Approved.

Model 1313
Remote Electronic
Frequency Counter

Model 1313P
Digital Readout

MERIAM engineers are dedicated to the design and manufacture of speed indicating instruments. Their achievements already include outstanding accomplishments in the fields of automation, jet engine development, automobile components, conveyor control, pumps and electric motors. This is why we say . . . specify a Meriam matched system of pulse pickups, counters and digital readouts from a wide variety of units which have been developed to meet the needs of virtually all applications. Meriam instruments are constructed for heavy-duty industrial use and, if required are available with explosion-proof housings for applications in hazardous areas.

THE **MERIAM** INSTRUMENT CO.

ILS ELECTRONIC DIVISION

Send for detailed specification charts for Meriam Electronic Speed Indicating Systems.

9006-MI

The Meriam Instrument Co.
I L S Electronic Division
10902 Madison Avenue, Cleveland 2, Ohio

Please send Bulletin No. 2000

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Company _____

Street _____

City _____ Zone _____ State _____

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Completely integrated SOHIO Toledo Refinery

Swagelok®

TUBE FITTINGS

SOHIO Selected SWAGELOK Tube Fittings for just one reason — MAXIMUM RELIABILITY. This Toledo Unit refines 60,000 bbls. of crude oil per day in ONE CONTINUOUS OPERATION. Just consider the absolute necessity for leakproof tube fittings within this installation. No room for failure here! A highly successful example of total integration, Standard Oil Company of Ohio's Toledo Refinery is a functioning tribute to engineering skill and mechanical performance.

FOR MAXIMUM RELIABILITY SPECIFY Swagelok Tube Fittings

Crawford Fitting Company • 884 East 140th Street • Cleveland 10, Ohio • Crawford Fittings (Canada) Ltd., Niagara Falls, Ontario, Canada

CIRCLE 26 ON READER-SERVICE CARD

IQS EVENTS

December 13-15

1960 Eastern Joint Computer Conference, Hotel New Yorker, New York. For information write John L. Whitlock, 253 Waples Mill Rd., Oakton, Va.

December 13-15

1961 Symposium on Thermoelectric Energy Conservation, Statler-Hilton Hotel, Dallas, Texas. For information write Paul H. Egli, Naval Research Laboratory, Anacostia, D.C.

January 17-19

ISA Winter Instrument-automation Conference & Exhibit, Sheraton-Jefferson Hotel, St. Louis, Mo. For information write W. Kushnick, 313 Sixth Ave., Pittsburgh 22, Pa.

January 30-February 3

ASTM National Meeting, Netherland Hilton Hotel, Cincinnati, Ohio. For information write ASTM, 1916 Race St., Philadelphia 3, Penna.

January 12-13

Conference on Reliability of Semiconductor Devices, Western Union Auditorium, 60 Hudson St., New York. For information write Advisory Group on Electron Tubes, 346 Broadway, 8th Flr., New York 13, N. Y.

January 9-11

Seventh National Symposium on Reliability and Quality Control, Bellevue-Stratford Hotel, Philadelphia, Pa. For information write R. L. Schwerin, Emerson Radio & Phonograph Corp., Jersey City 2, N. J.

February 1-3

Second Winter Military Electronics Convention (MILECON), Biltmore Hotel, Los Angeles, Calif. For information write A. N. Curtiss, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

February 2nd-3-4

6th Annual ISA North Central Area Automation Symposium—, Radisson Hotel, Minneapolis. For information write Mr. Howard Marston, Honeywell, 621 E. Honnepin Ave., Minneapolis.

March 8-10

11th Annual ISA-CONFERENCE on Instrumentation For the Iron & Steel Industry. Contact: Richard R. Webster, Jones & Laughlin Steel Corp., Research Laboratory, 900 Agnew Ave., Pittsburgh 30, Pennsylvania.

March 20-23

1961 IRE International Convention, Waldorf-Astoria Hotel and New York Coliseum, New York, N. Y. For Information write Dr. Gordon K. Teal, the Institute of Radio Engineers, Inc., 1 East 79th St., New York 21, N. Y.

Another FIRST!

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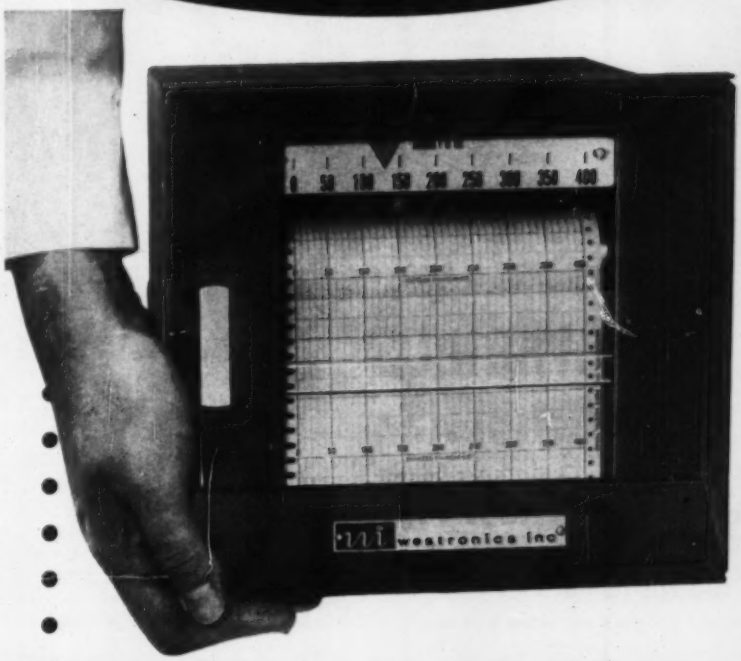

MINIATURE MULTIPOINT RECORDER

12 POINTS ON 5 INCH CHART

westronics, INC.

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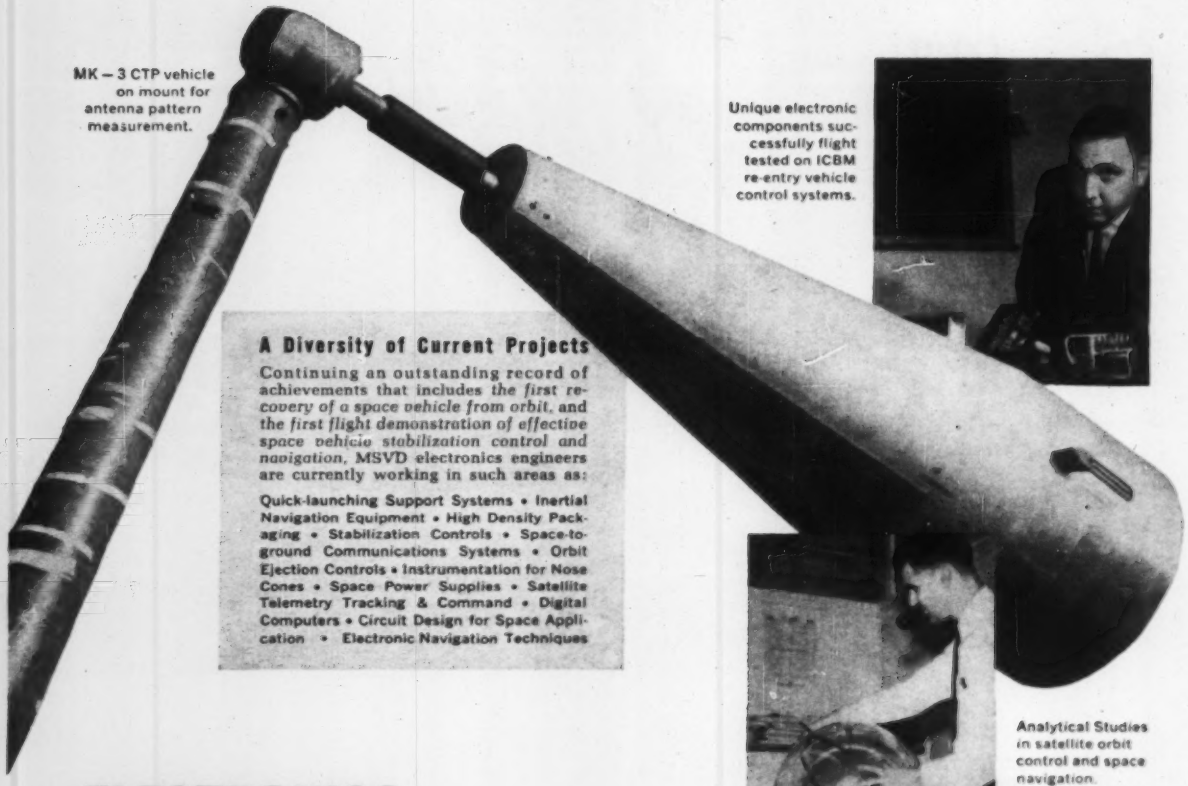
CIRCLE 27 ON READER-SERVICE CARD



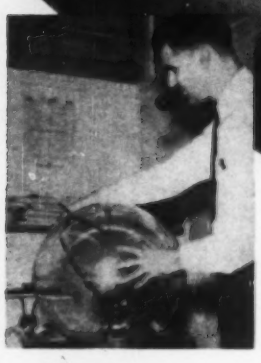
MK – 3 CTP vehicle on mount for antenna pattern measurement.

Unique electronic components successfully flight tested on ICBM re-entry vehicle control systems.

A Diversity of Current Projects

Continuing an outstanding record of achievements that includes *the first recovery of a space vehicle from orbit*, and *the first flight demonstration of effective space vehicle stabilization control and navigation*, MSVD electronics engineers are currently working in such areas as:

Quick-launching Support Systems • Inertial Navigation Equipment • High Density Packaging • Stabilization Controls • Space-to-ground Communications Systems • Orbit Ejection Controls • Instrumentation for Nose Cones • Space Power Supplies • Satellite Telemetry Tracking & Command • Digital Computers • Circuit Design for Space Application • Electronic Navigation Techniques



Analytical Studies in satellite orbit control and space navigation.

ELECTRONICS ENGINEERS

AT GENERAL ELECTRIC YOU CAN APPLY YOUR COMMAND OF ELECTRONICS TO THE NATION'S MOST ADVANCED SPACE PROBLEMS

Today, engineers with TV and radio experience are working on missile and space vehicle payload problems at GE's *Missile & Space Vehicle Department*... others are applying their knowledge of radar to space communications... men with aircraft navigation experience are concentrating on advanced guidance and control systems for interplanetary space vehicles... In fact, engineers with experience in practically every area of electronics have transferred their technical knowledge directly to space problems.

Whether or not you've had specific experience in space electronics, you may be able to go right to work at MSVD on some of the most sophisticated and technologically exciting projects in the entire space field – from ICBM re-entry vehicles to operational space craft.

The work here is at the very edge of the state of the art, transforming the latest research discoveries into workable engineering solutions. You'll be concerned with new advances in plasma physics, thermoelectric phenomena, telemetry... with radical new requirements in micro-miniaturization, space to weight reductions, performance efficiency... with an entirely new order of reliability specifications to assure systems' operation in space for a year or longer.

Excellent positions are currently open in four major areas at MSVD: Navigation and Control Engineering • Instrumentation and Communications Engineering • Ground Support Engineering • Advanced Systems Engineering

These positions will place you on the ground floor of the move of a large segment of the Department to the new Space Technology Center—located at Valley Forge Park, just 17 miles from Philadelphia.

Inquiries are invited from electronics engineers who are technically advanced in their own discipline, and are deeply interested in the related fields of space vehicle development. Write informally, or forward your resume to: D. G. Curley, Div. 143-ML.

MISSILE & SPACE VEHICLE DEPARTMENT

GENERAL ELECTRIC

3198 Chestnut Street, Philadelphia 4, Pennsylvania

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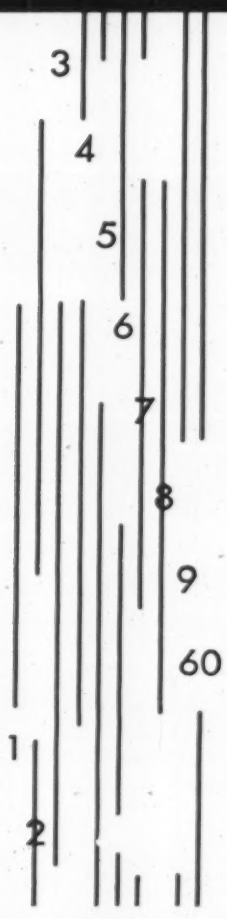
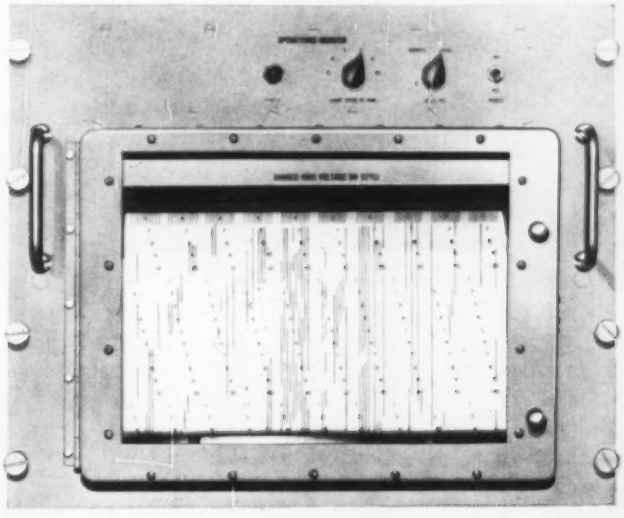


verify events permanently in milliseconds

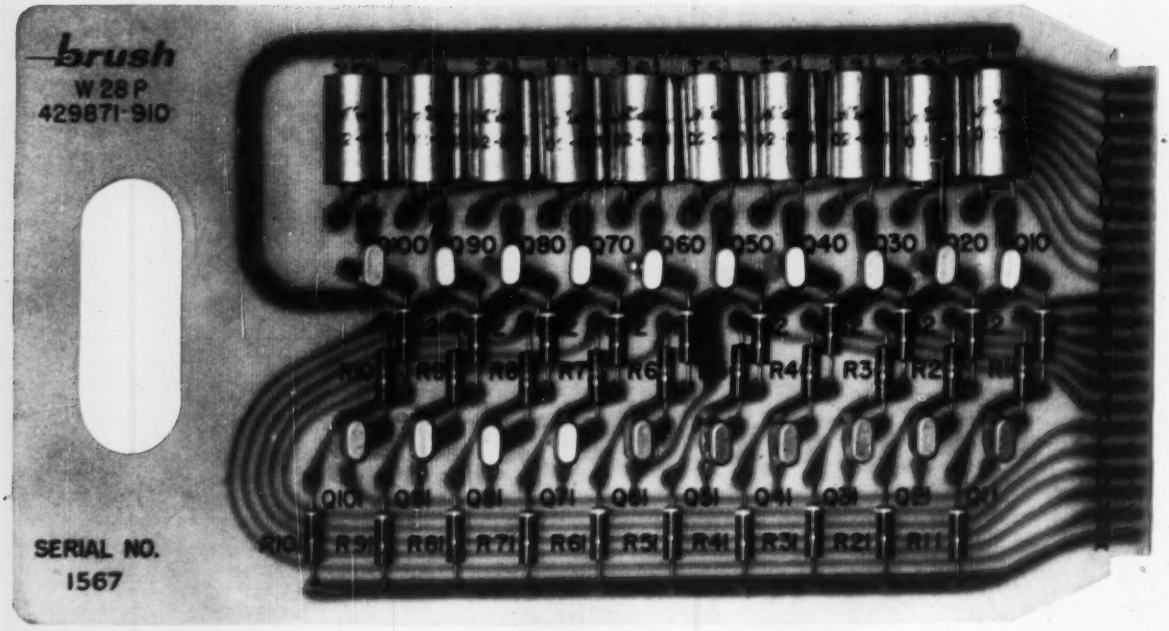
Brush Operations Monitors' response to signals is virtually instantaneous—less than 4 milliseconds. Multiple high-speed events are clearly defined from start to stop, on a common time base—and at rates up to 500 per second. Portable 30 channel or rack-mounting 100 channel models record sharp reproducible traces with fixed-stylus electric writing that provides the utmost in reliability. "Built-in" transistor switching to eliminate relays is optional. No direct writing recording system can match the capabilities of Brush Operations Monitors for industrial and military analysis and control. Write for complete specifications and application data.

brush INSTRUMENTS
DIVISION OF
37TH AND PERKINS CLEVITE CORPORATION CLEVELAND 14, OHIO



→

compact transistor switching for millisecond monitoring



The new Brush Trans-Switcher eliminates relays—greatly simplifies your problems of operations monitoring. Designed to take full advantage of the fast response and high resolution of Brush Operations Monitors, this compact, solid-state switching unit accepts up to 100 different "on-off" signals in a broad range of pulse shapes and amplitudes. Interchangeable, plug-in decade boards are designed to accept different voltage ranges and modes of operation. Avoid the "black box" approach—specify the *standard* Brush Trans-Switcher for the ultimate in precise, reliable monitoring. Write for complete details.

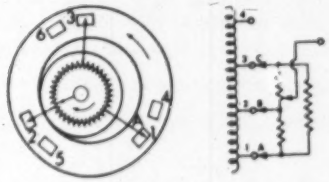
brush INSTRUMENTS

DIVISION OF CLEVITE CORPORATION

37TH AND PERKINS CLEVELAND 14, OHIO

The Vernistat

In Series 1 and 2 Vernistats, discrete voltage levels are provided by a tapped autotransformer whose taps are connected to a flat printed circuit commutator. A toroidal resistance element of three 120° sections interpolates between the commutator bars, and is



switched along the commutator as the shaft of the Vernistat is turned . . . The output wiper is so synchronized with the switching operation that it is always on an energized section of the resistance element. This results in continuous smooth interpolation throughout the output voltage range . . . (*From new 12-page brochure, Vernistat Div., Perkin-Elmer Corp., Norwalk, Conn.*)

FOR THIS LITERATURE CIRCLE 159 ON READER-SERVICE CARD

Algebraic Compiler

Algo follows the principles laid down for the universal algebraic computer language, Algol, proposed for international use by computer organizations in America and abroad . . . In this manual, upper case letters designate the characters which Algo recognizes of alphabetic operators, multi-character identifiers, and declaration names. The other char-

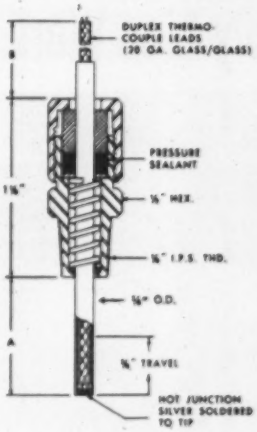
Operator	Equation	Algo Algebraic Statement
ABS	$c=a+\|b\|$	c=a+ABS b
ABS	$z=x\|y\|$	z=x*ABS y
ABS	$f=a-\|b+c\|$	f=a−ABS(b+c)
ABS	$a=\|xy\|/z$	a=ABS(x*y)/z

acters need not be typed. For example, in the word SUBSCript, the first five characters are recognized by Algo. The programmer may or may not type the last four characters. The programmer may type either upper or lower case alphabetic characters with no difference in effect . . . For his problem, the programmer may choose from two types of subordinate processes, Procedures and Functions. The difference between the two is the method of communication between the subordinate process and the program. The programmer must decide which type is the best method for the requirements of his problem. The differences between Procedures and Functions are discussed in detail in a later section . . . (*From new 32-page Manual "Algebraic Compiler for the Bendix G-15, General-purpose Digital Computer," Bendix Computer Div., 5630 Arbor Vitae St., Los Angeles 45, Calif.*)

FOR THIS LITERATURE CIRCLE 160 ON READER-SERVICE CARD

ICS BRIEFS

Spring-loaded Thermocouples

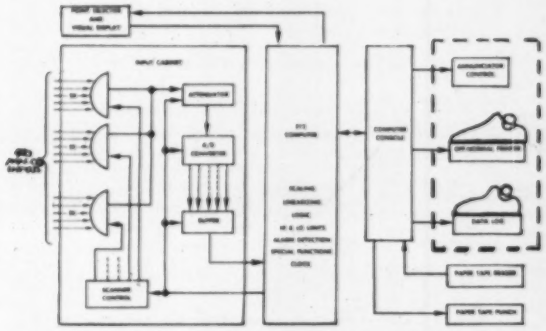


Spring loading insures firm contact for thermal conductivity . . . seals internal vacuum or pressure to 200 psi, eliminates entry of foreign matter into system . . . used for checking surface temperatures, injection molding machine temperatures and hundreds of other applications up to 500°F . . . (*From new 32-page Catalog 1890, Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.*)

FOR THIS LITERATURE CIRCLE 161 ON READER-SERVICE CARD

Digital Control Computer

The GE 312 Digital Control Computer is a general-purpose stored-program digital computer. Provided as standard equipment with this computer are a computer console, an electric typewriter, a paper tape punch and a paper tape reader. With appropriate



auxiliary equipment, it is capable of handling large quantities and varieties of analog and digital input and output signals . . . Two instruction systems, either the single-address or one-plus-one mode, may be intermixed in the program . . . Improved performance and life are provided by the exclusive use of transistors, diodes and other solid state devices—eliminating the use of vacuum tubes . . . (*From new 8-page Bulletin GEA-6884A, General Electric Co., Computer Department, Phoenix, Ariz.*)

FOR THIS LITERATURE CIRCLE 162 ON READER-SERVICE CARD

← CIRCLE 29 ON READER-SERVICE CARD

IDEAL

Thermo-Tip®

RESISTANCE SOLDERING TOOLS

NEW easier-to-handle "Pistol-Grip" Style

Speed Assembly Line Work

up to

42%*

greater reliability for soldering pin-type plugs, aircraft connectors, wire-to-wire, terminals, instruments, printed circuits, electronic systems and parts.

- higher soldering speed reduces costs
- higher-quality connections — fewer rejects
- better, more accurate work on miniaturized assemblies
- light, easy-to-handle — women can use all day without fatigue
- entirely safe, heat only on contact — no operator burns

*Proved by on-the-job comparisons . . . ask for Bulletin C217

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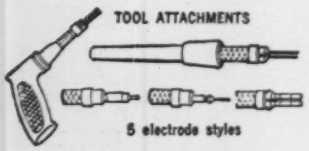

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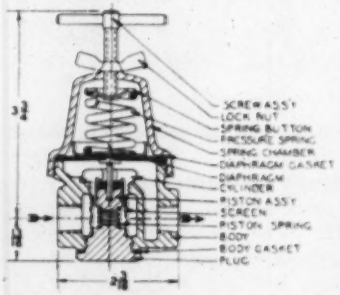
ICS BRIEFS

Pressure Regulators

The in-line Model A is most suitable for air or water, is ideal for use on equipment requiring close regulation, good capacity, and installations where

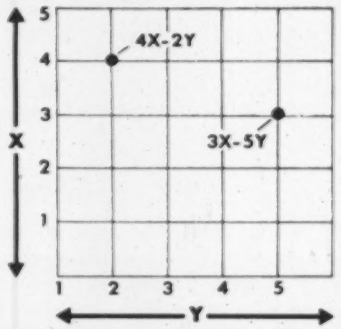


space limitations and flexibility of hook-up are important factors. Suitable for other liquids and gases . . . (*From new 8-page Bulletin* 91021, *Airmatic Valve, Inc.*, 7313 *Associate Ave., Cleveland 9, Ohio.*)

FOR THIS LITERATURE CIRCLE 163 ON READER-SERVICE CARD

New Concept in Patchboards

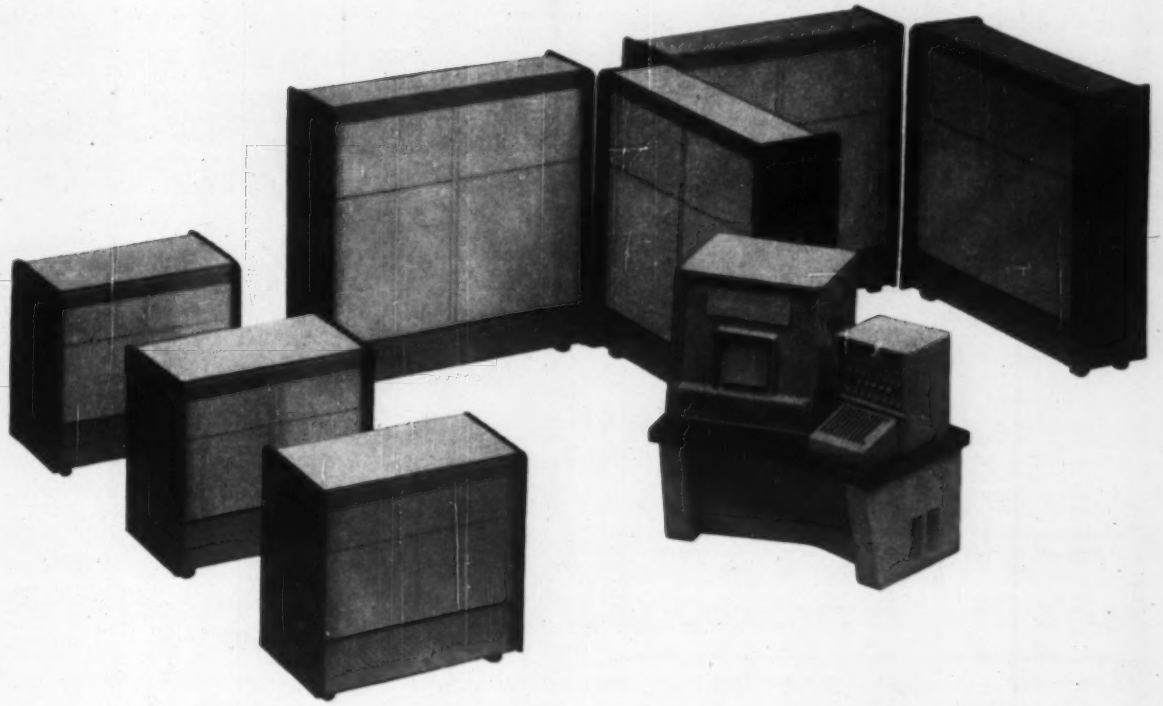
The Sealectroboard offers a new degree of versatility in interconnecting electronic circuitry, interposition of components, and a virtually unlimited number of other functions associated with the design, maintenance and operation of circuits containing a multiplicity of interconnectable circuit elements . . .



Any number of Sealectroboard shorting plugs may be used simultaneously to establish the desired X-Y logic required. Circuitry terminations are made at the terminal ends of the X and the Y axis strips. The desired interconnections are made by insertion of the shorting plug at the appropriate intersection. Any number of functional characteristics may be established in this programming by means of multiple insertions, and, if desired, paralleling terminations, thus setting up varying logics to be programmed through shorting or component plugs . . . (*From new 4-page bulletin, Sealectro Corp.*, 139 *Hoyt St., Mamaroneck, N. Y.*)

FOR THIS LITERATURE CIRCLE 164 ON READER-SERVICE CARD

LFE's new RD-900 system--



. . . provides a random access file of up to 495 million bits with access to information in less than 3/10 of a second.

. . . may be operated with all standard general purpose digital computers, or as an independent storage, access and display system.

The RD-900 Random Access Storage and Display System, consists of from 1 to 33 high density, magnetic, file drums, each with a storage capacity of 15 million bits. A Symbol Generator converts coded characters into a visual message as fast as they are read from the file. One Symbol Generator is used to drive any number of output display devices. These include 21" console displays and large screen projection displays . . . each capable of displaying up to 12,800 characters, symbols or a composite of both. In addition to alphanumeric characters the system can display arbitrary or abstract symbols, schematic or logical drawings, graphs, charts, and maps. Applications include military and industrial systems where information retrieval and display must be simultaneous for instant decision making. For a complete description and specifications write Dept. 101.

LFE
COMPUTER PRODUCTS DIVISION

LABORATORY FOR ELECTRONICS, INC.

1079 COMMONWEALTH AVE. • BOSTON 15, MASSACHUSETTS

CIRCLE 31 ON READER-SERVICE CARD

REMOTE BULB, INDICATING TEMPERATURE CONTROL E32N

Featuring Control Point Accuracy Equivalent to Individually Calibrated Instruments

The **UNITED ELECTRIC** Type E32N Temperature Control is a uniquely designed instrument that is used to control and indicate temperatures of gases, liquids or hot plates over wide ranges. This unit contains a 12-inch scale for easily read visual indications. It is possible to replace the thermal unit in the field without any loss of calibration accuracy.

Temperature Ranges	—150°F. to 150°F., 70°F. to 370°F., 100°F. to 650°F. Read temperature on continuous, 12-inch indicating scale that rotates against a fixed index pointer in a vertical and centered location.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
On-Off Differential	Approximately 1.0°F. or 2.0°F. dependent on model.
Adjustment	Calibrated dial rotated against a fixed index.
Calibration	Calibrating mechanism permits precise matching of scale to individual tolerance errors of thermal assemblies.
Compensation	Automatic compensation for ambient temperatures.

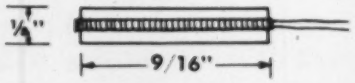
SEND FOR NEW Catalog 200 for full information on the E32N and other remote bulb temperature controls.

United Electric Controls COMPANY
82 SCHOOL STREET WATERTOWN MASS

CIRCLE 32 ON READER-SERVICE CARD

Weldable Strain Gages

The SS-E-5 is a folded filament gage with leads on one end of the gage. This gage has a resistance of 60 ohms . . . Micro-Test has developed a method of processing its gages so that they can be welded directly to alloys of aluminum without special pre-

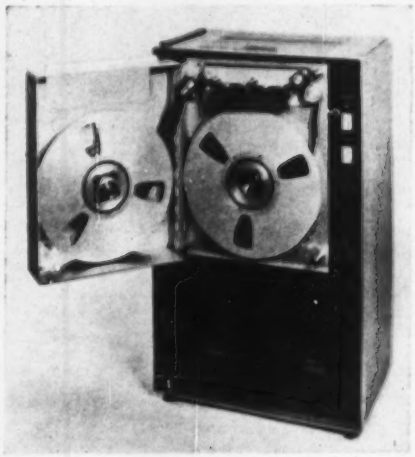


paration of the surface of the specimen . . . Micro-Test Gages have been welded successfully to the following metals: cast iron-aluminum, magnesium-thorium, magnesium-titanium, all ferrous metals. Special features include: simple, rapid, dependable installation; relatively unaffected by atomic radiation; highest resistance to ground at all temperatures; lowest apparent strain vs. temperature; high allowable strain levels—8,000 μin per in.—(*From new 4-page Bulletin* 401, *Micro-Test, Inc.*, 1718 *Twenty-First St., Santa Monica, Calif.*)

FOR THIS LITERATURE CIRCLE 165 ON READER-SERVICE CARD

Instrumentation Magnetic-tape Recorders

The PS-200 instrumentation magnetic tape recorder combines the advantages of transistorized electronics with a stacked reel tape magazine. These developments permit a reduction of approximately 10 to 1 in size, weight, and power consumption over



comparable existing equipment, with no degradation in flexibility or performance. A unique feature is its stacked reel magazine. The magazine is designed so that it can be completely removed from the transport or opened while attached to change reels . . . The PS-200 can be quickly converted to a loop transport by simply exchanging the reel-to-reel magazine for a loop magazine . . . (*From new 8-page Bulletin* 55, *Precision Instrument Co.*, 1011 *Commercial St., San Carlos, Calif.*)

FOR THIS LITERATURE CIRCLE 166 ON READER-SERVICE CARD

INSTRUMENTATION
FOR AUTOMATION

Now, with 12 standard ranges, General Electric Mass Flowmeter

PERFORMANCE PROVED

. . . ON THE LINE! Today, many companies in the petroleum, chemical, petrochemical and natural gas industries are accurately measuring valuable process fluids directly in pounds with the General Electric True-Mass Flowmeter.

For example, these 12 applications have been performance-proved in actual service metering:

- **air • natural gas • alcohol • vinyl chloride**
- **freon • penicillin • liquid carbon dioxide**
- **ethylene • liquid petroleum gas • naphtha**
- **jet fuel • methane hydrogen mixtures**

(Many more to come—let us know what your specific application is.)

NEW ACCESSORIES FOR APPLICATION FLEXIBILITY:

Now, you can control batch blending accurately on a system basis with this flowmeter and new accessories which include:

counters—permit remote digital readout; **pre-set counters**—for automatic blending; **ticket and tape printers**—allow permanent and remote recording of flow.

AND ALL MODELS FEATURE:

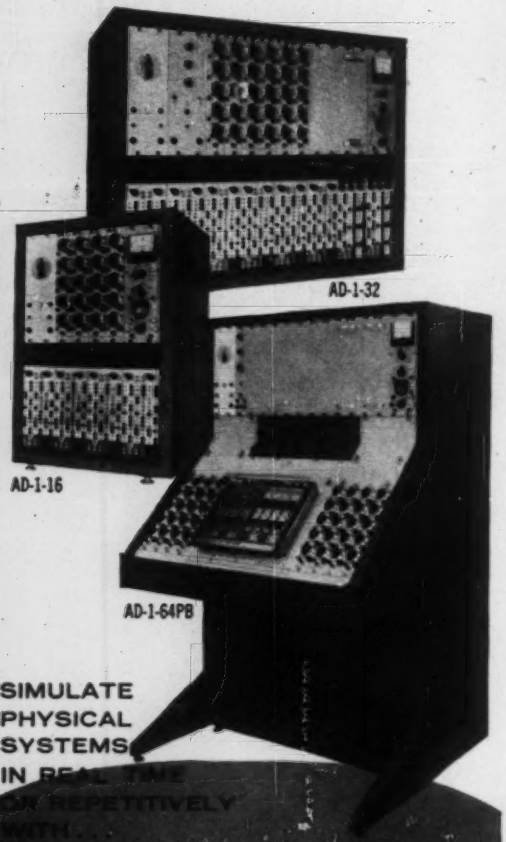
- Accuracy independent of variations in density, pressure, viscosity and temperature
- Completely self-contained, self-integrating unit
- Low pressure drop
- Accuracy unaffected by fluctuation in power supply voltage and frequency
- Long-term stability for minimum maintenance and infrequent field calibration
- Quick response to rapid changes in flow without overshoot or lag
- Measurement in pounds—eliminates tedious conversions

DO YOU HAVE AN APPLICATION for this revolutionary new instrument? Chances are you do, and we'd like to know about it. Contact your nearby G-E Sales Office, or write directly to General Electric Co., Section 599-03, Schenectady 5, N. Y. Be sure to ask for bulletin GEA-6925A. In Canada, contact Canadian General Electric Co., 940 Lansdowne Avenue, Toronto 4, Ontario. On applications in the natural gas industry, contact Black Sivalls and Bryson, Inc., P.O. Box 1714, Oklahoma City, Okla.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 33 ON READER-SERVICE CARD



SIMULATE PHYSICAL SYSTEMS IN REAL TIME OR REPETITIVELY WITH . . .

Applied Dynamics Analog Computers

SERIES AD-1

Modular Design For Plug-in Expandability and Maximum Reliability

- Diode-diode-diode multipliers and function generators
- Stepping switches matched to .01%
- Repetitive operation with electronic reset and simultaneous real-time operation
- Continuous overload monitoring and integral balance check system

AD-1 Series analog computers are available with from 4 to 64 amplifiers for solution of various types of linear and non-linear equations.

The AD-1-64PB features a removable preprogrammed patchboard with up to 64 stabilized amplifiers, 80 coefficient potentiometers, 16 multipliers, 8 function generators, and 20 diode networks.

The AD-1-32 and AD-1-16 feature a fixed patchboard system with up to 32 and 16 amplifier capacity and non-linear equipment for maximum economy.

Modular design permits flexible arrangements to suit various operating requirements.

Applied Dynamics, Inc.

A Subsidiary of Electronic Associates, Inc.

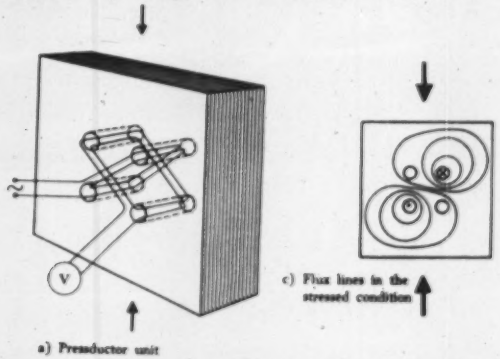
ANN ARBOR, MICHIGAN

Specialists in Industrial and Process Instrumentation and Controls

CIRCLE 34 ON READER-SERVICE CARD

High-output Load Cell

The Pressductor is a load-cell of the permeability class, i.e. it is based upon the fact that the permeability of the magnetic material is influenced by mechanical stress. For a material with positive magnetostriction, compression decreases the permeability in the direction of the stress, and increases it to a smaller degree at right angles to the stress, while tension has

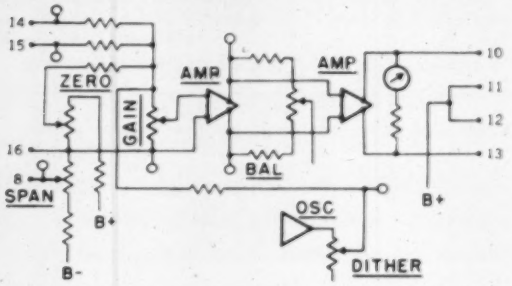


the opposite effect . . . The Pressductor can be described as a "misdesigned" transformer in which the primary and secondary windings are so placed that the coupling between them is zero in the mechanically unloaded state . . . If the Pressductor is subjected to compressive stress, the permeability is reduced in the direction of the stress, and thus the flux has a tendency to be deviated to the transverse direction by an amount proportional to the impressed force . . . (*From new* 12-*page Bulletin* 7707E, *Asea Electric, Inc., Vasteras, Sweden.*)

FOR THIS LITERATURE CIRCLE 167 ON READER-SERVICE CARD

Plug-in Servo Amplifier

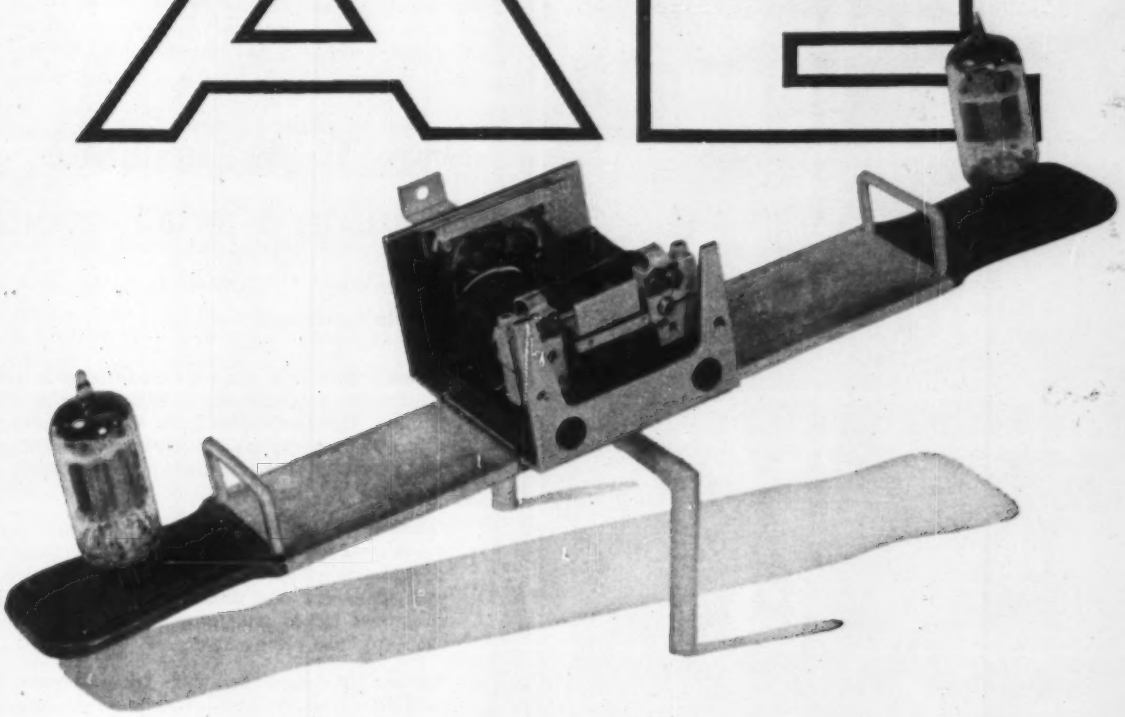
Model No. SA-2001-P DC Servo Amplifier provides a 30 milliampere differential output with a quiescent current of 15 milliamperes. Overall modular construction allows the amplifier to be partially withdrawn for adjustment and testing as well as completely re-



moved for maintenance. Plug-in sub-assemblies (relays, digital circuits, power supplies, etc.) permit maximum flexibility by allowing the type of input and output, the quiescent current and the maximum gain to be easily changed by substituting alternate plug-in amplifiers . . . (*From new folder containing* 9 *sections of spec sheets, Plug-In Instruments, Inc.,* 1416 *Lebanon Rd., Nashville* 10, *Tenn.*)

FOR THIS LITERATURE CIRCLE 168 ON READER-SERVICE CARD

AE



To the Engineer

looking for a fast circuit seesaw

If you're in need of something better than a flip-flop that only *partially* transfers a circuit —something with a transit time of less than a millisecond—then you'll be delighted with AE's Series PTW Polar Relay. This magnetically biased relay will transfer a circuit with the beautiful regularity of an observatory clock, and trigger on only a few mils from your available energy source.

Substantially smaller than other polar relays, the PTW's unique design virtually guarantees the high-speed switching of a single circuit *billions of times without readjustment!* Its service records to date in telegraph and teleprinter circuits and differential controls suggest that its life is practically limitless. Terminals to meet your specs.

Our circuit engineers will be happy to work with you in adapting the PTW to your designs. Or possibly you'd like to leave the switching to us—in which case we can take on the complete packaging and more than likely shave your costs.

For full information on the PTW, ask for Circular 1821-E — *and* for answers to your control problems, write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

AE CAN DO

AUTOMATIC ELECTRIC

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL TELEPHONE SYSTEM

CIRCLE 35 ON READER-SERVICE CARD

How to get accurate data on a small recorder

Ampex's new CP-100 nicely balances four desirable qualities

Compact. Definitely, and a great advantage in trailers, in airplanes, in submarines, or even in regular laboratory use. There's complete front access to everything. All-transistor amplifiers and power supplies cut power needs and keep down the heat — an advantage in tight equipment layouts.

Portable. We'll frankly admit it takes two men to carry it — not just one and a half. But by calling in an occasional fractional man (or by using an accessory dolly) you gain exactly the needed performance that portables have lacked until now. In laboratory use, the CP-100 is "bench-top equipment."

Precise. Let the numbers talk. Though compact, the CP-100 is a full-fledged, uncompromised laboratory recorder: 200 kc response at 60 ips tape speed (and proportional at others); flutter well within telemetered-data requirements; intermodulation distortion so low it never adds spurious data of its own.

Universal. Yes, in numerous ways. The CP-100 isn't fussy about power; takes 115 or 230-volt AC at 50, 60 or 400 cycles or 28-volt DC from batteries or generator. Kinds of data: direct or FM-carrier, by interchangeable plug-in amplifiers. And it records and plays back as well.

The essential data

Model: CP-100 Compact Recorder/Reproducer. *Reel size and tape width:* 10½-inch reels with ½- or 1-inch tape (as specified). *Types of recording:* direct or FM carrier by plug-in interchangeable amplifiers. *Tape speeds:* 60, 30, 15, 7½, 3¾ and 1⅞ ips. *Frequency response:* direct, 300 to 200,000 cps ± 3 db at 60 ips; FM carrier, 0 to 20,000 cps at 60 ips; response at other speeds proportionate. *Tape compatibility:* yes, with Ampex FR-600, AR-200 or interchangeable with FR-100, FR-1100, 300 and 800 series.

May we tell you more? Please write

AMPEX

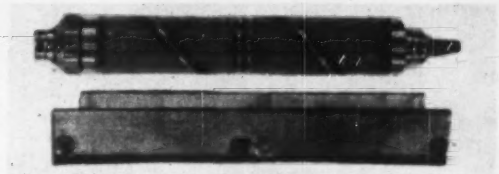
AMPEX DATA PRODUCTS COMPANY

Box 5000 • Redwood City, California • EMerson 9-7111

CIRCLE 36 ON READER-SERVICE CARD

Helical Commutator

The Helicom operates in a helical mode to give separate wear surfaces for each commutated data channel. Magnetic techniques are used to generate a trigger wave-form for channel synchronization. The result is a simply designed, reliable switch with a proven low wear rate. The sampling switch is suitable for either 2 pole 60 or 2 pole 45 sampling . . . Contact

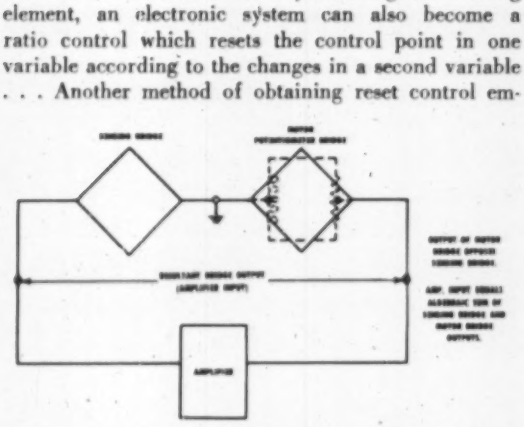


resistance is a few tenths of an ohm, generated noise is in the low microvolt range, and interchannel leakage resistance is hundreds of megohms. Pulse rise time is 3 usec. A magnetic pulse generator provides clean edge triggering throughout life. Power requirements are low . . . (*From new 8-page brochure, Lind Instruments, Inc.*, 357 Nassau St., Princeton, N. J.)

FOR THIS LITERATURE CIRCLE 169 ON READER-SERVICE CARD

Application of Electronic Controls

Ratio or Reset Control: By dividing the sensing element, an electronic system can also become a ratio control which resets the control point in one variable according to the changes in a second variable . . . Another method of obtaining reset control em-

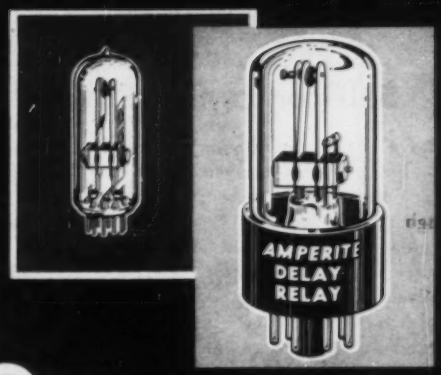


ploys an auxiliary bridge circuit, as indicated in Fig. 17 . . . Equipment of this type provides a high degree of flexibility since the reset ratio can be changed at any time by means of a simple adjustment at the panel . . . The ratio adjustment is variable from 0.5:1 to 20:1. From these ratios it is evident that the auxiliary sensing element can exercise varying degrees of authority from twice the authority of the main sensing element to 1/20 of that element. Adjustment between these extremes is continuous . . . (*From new 20-page "Electronic Handbook," Barber-Colman Co., Rockford, Ill.*)

FOR THIS LITERATURE CIRCLE 170 ON READER-SERVICE CARD

AMPERITE

Thermostatic DELAY RELAYS



Only a glass seal offers true hermetic sealing . . assuring maximum stability and life!

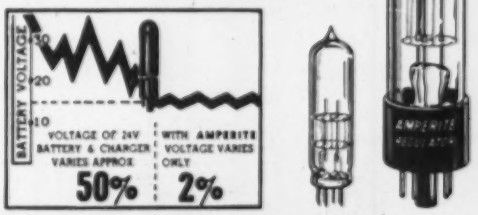
Delays: 2 to 180 seconds . . . Actuated by a heater, they operate on A.C., D.C., or Pulsating Current . . . Being **hermetically sealed,** they are not affected by altitude, moisture, or climate changes . . . **SPST only**—normally open or normally closed . . . Compensated for ambient temperature changes from —55° to +80° C. . . . Heaters consume approximately 2 W. and may be operated continuously . . . The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.** Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

AMPERITE

BALLAST REGULATORS



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—50° to +70° C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE

561 Broadway, New York 12, N. Y. . . . CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

CIRCLE 37 ON READER-SERVICE CARD

BRIEFS

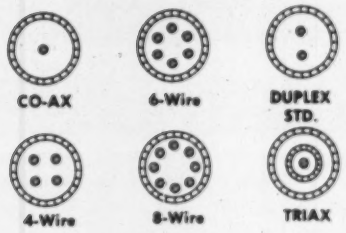
scale . . . (*From new 4-page Bulletin CE 1-317, Century Electronics & Instruments, Inc., Box 6216, Pine Station, Tulsa 10, Okla.*)

FOR THIS LITERATURE CIRCLE 171 ON READER-SERVICE CARD

Portable Null-balance Recorder with Self-contained Power

The Century Null-Balance Recording Potentiometer . . . provides the sensitivity and reliability of larger laboratory recording potentiometers even though it only weighs 12 pounds including the self-contained battery power supply. Single and dual-channel units, designated Model 450 and 453, respectively, are available . . . The self-contained power supply may consist of either 8 standard "D" size flashlight cells, or 8 of the physical equivalent mercury cells. When long, unattended operation is contemplated, the mercury cells may be used to provide all the power necessary to operate the entire recorder for a period in excess of 200 hours. This includes the chart-drive motor, as well as the power amplifier used to drive the balancing motor . . . Recorder is powered by standard "D" cells, fully transistorized, has completely modular construction; 100 millivolt full scale sensitivity; accuracy better than ½% full

Metal-sheathed Thermocouples



HARCO Metal Sheathed Thermocouples . . . consist of sheath, wire and ceramic insulation combined to produce tough and flexible temperature sensing instruments . . . Thermocouples are made with one, two, four, six, or more wires encased in hard compacted high purity alumina oxide, magnesium oxide or zirconium oxide and are sheathed in metal . . . (*From new 4-page, Catalog Supplement 161, Harco Laboratories, Inc., New Haven, Conn.*)

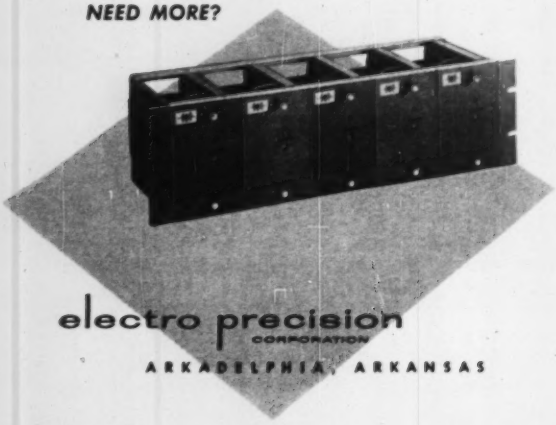
FOR THIS LITERATURE CIRCLE 172 ON READER-SERVICE CARD

THE *Finest* IN OPERATIONAL AMPLIFIERS

ELECTRO PRECISION CORPORATION'S VERSATILE MODEL DLA-41

The unusual combination of bandwidth plus stability make this amplifier easier to apply to your problem than any other. Only the DLA-41 offers you a 40KC bandwidth, and yet is so stable with various feedback configurations.

NEED MORE?

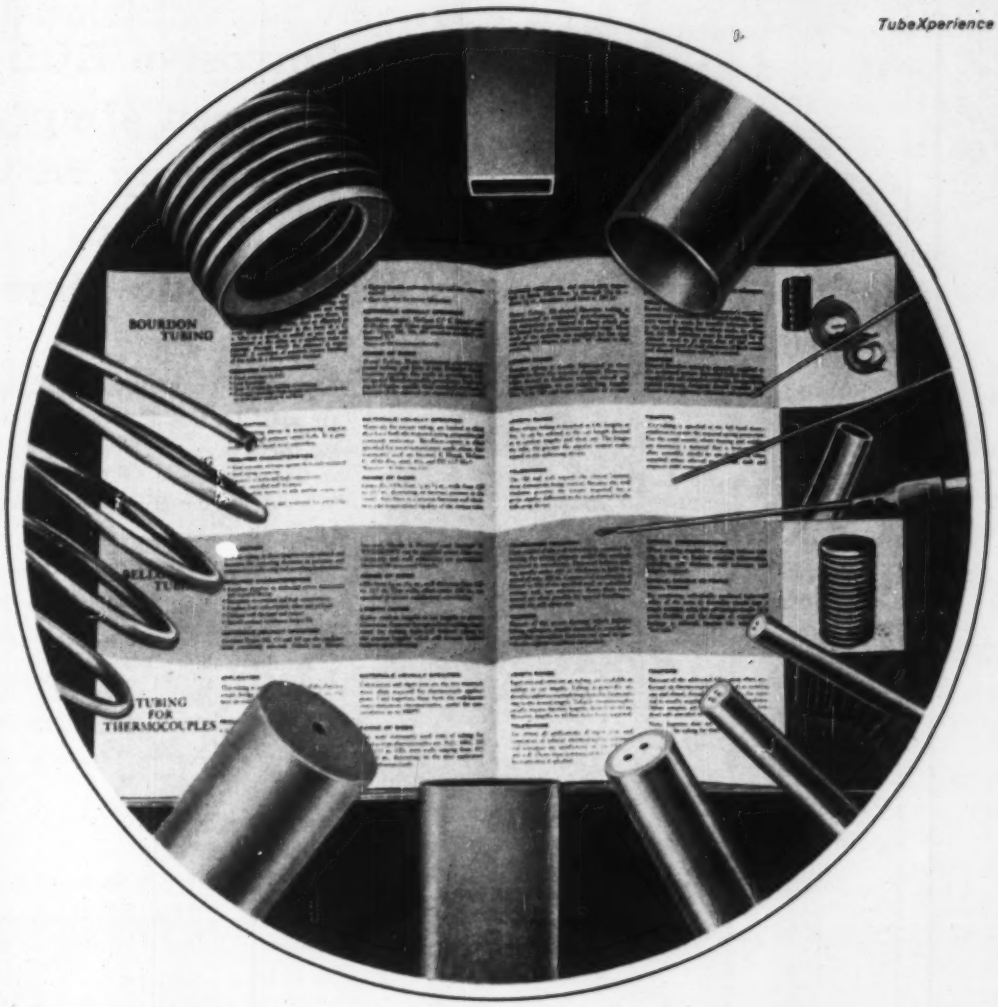


The Model DLI-520 Amplifier Group contains five DLA-41 Operational Amplifiers, yet only occupies only 5¼" of panel space in a standard 19" rack. Ideal for building special purpose computers and you have the assurance of the finest amplifiers for precision computing.

The DLI-520A Amplifier Group contains three DLA-41 Operational Amplifiers and two regulated 300 volt power supplies. Occupying 5¼" of panel space, the Model DLI-520 is ideal for special purpose computing applications.

electro precision CORPORATION
ARKADELPHIA, ARKANSAS

CIRCLE 38 ON READER-SERVICE CARD



TUBEXPERIENCE PREPARES A NEW INSTRUMENT BULLETIN —GUIDE TO SELECTION AND APPLICATION OF INSTRUMENT TUBING

Superior's long experience in producing small-diameter metal tubing to extremely close tolerances enables it to offer instrument designers and makers a wide variety of materials, sizes, metallurgical competence, and manufacturing skills that save experimentation in the design stage . . . time and cost in production.

"Specialty Tubing for Industrial Instrumentation"—a new bulletin by Superior just off the press—puts into print for the first time comprehensive information that covers all types of Superior tubing for the instrument field. It includes required characteristics, materials usually specified, range of sizes, tolerances, tempers, and special considerations for thermometer-bulb, capillary, Bourdon, bellows, fire detection, linkage, recording-pen and torque tubing; also tubing for thermocouples and gas chromatography.

Send for a copy of this valuable bulletin today. The information covered will greatly help your selection of tubing for all measuring, indicating, recording and control devices. If you have a problem involving tubing, call on us to help you solve it. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

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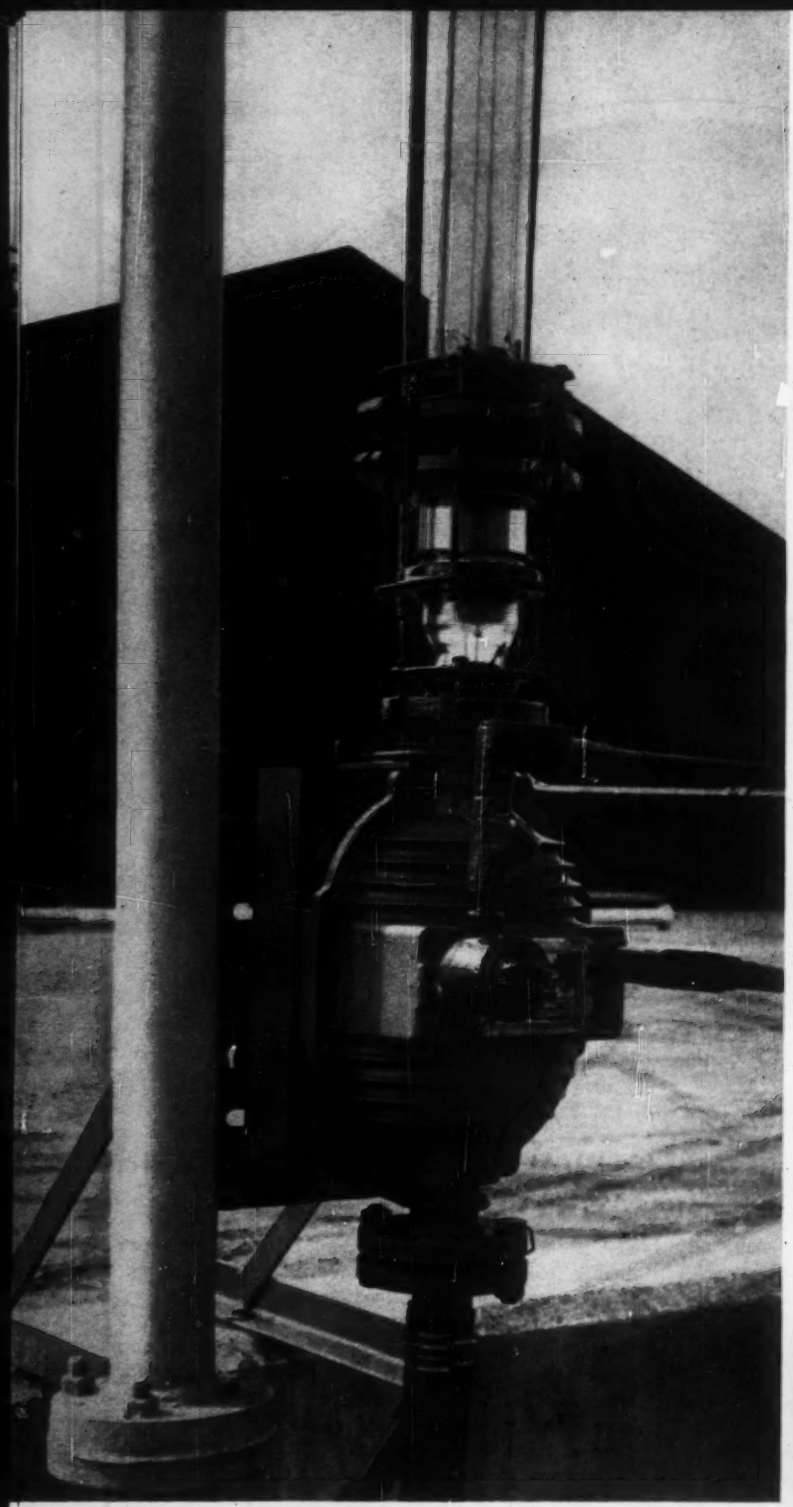
The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

CIRCLE 39 ON READER-SERVICE CARD



Corrosive HCL... metered simply, accurately with the Foxboro Magnetic Meter

"Meter is completely corrosion proof," Cabot Carbon Company reports

When you're metering hydrochloric acid for billing to a customer — for a price — accurate measurement becomes important. But how can you get it with a liquid as corrosive as 33% HCL?

At the Cabot Carbon Company, Tuscola, Illinois, the Foxboro Magnetic Meter is the best answer. There's nothing to corrode or plug up — no flow restrictions of any type. Plus metering accuracy of better than ±1%. An "impossible" measurement made simple, accurate, continuous.

If you have a difficult liquid in your plant, the Foxboro Magnetic Meter can pay off for you, too. Ask your Foxboro Field Engineer about it or write for Bulletin 20-14. The Foxboro Company, 4612 Norfolk Street. Foxboro, Massachusetts.

FOXBORO

REG. U.S. PAT. OFF.

MAGNETIC FLOW METERS

2" Foxboro Magnetic Meter measures 33% hydrochloric acid leaving the Cabot Carbon plant at Tuscola, Illinois. Meter has a Teflon lining, platinum electrodes — completely resists corrosion.

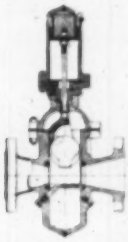
Foxboro Dynalog* electronic recorder logs acid flow. Chart records are attached to customer's monthly invoice as proof of delivery.

*Reg. U.S. Pat. Off.

CIRCLE 40 ON READER-SERVICE CARD

Integral Cylinder Valves

The P-K Paul Integral Cylinder Valve is a self-contained, self-regulating valve that requires no outside power source for operation . . . The valve will maintain any predetermined downstream pressure of flow requirement without an outside controller. (A

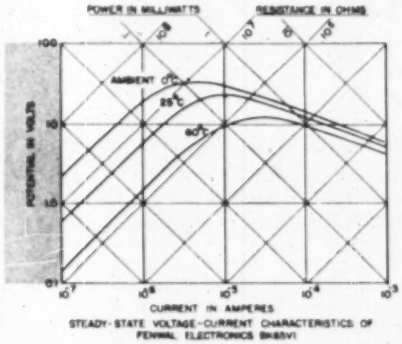


pressure pilot valve is required to sense the downstream pressure. An adjustable orifice can be supplied if a variable speed of operation is required) . . .(*From new 16-page Catalog GV 102, General Kinetics Corp., 197 South Van Brunt St., Englewood, N. J.*).

FOR THIS LITERATURE CIRCLE 173 ON READER-SERVICE CARD

What Do Thermistors Do?

Thermistors are "thermal resistors" or resistors with a high negative temperature coefficient of resistance . . . Thermistors are semi-conductors of ceramic material made by sintering mixtures of metallic oxides such as manganese, nickel, cobalt, copper, iron, and uranium . . . There are three important characteristics of thermistors that make them useful in electronic and electrical circuits. (1) Resistance-temperature characteristics . . . (2) Voltage-Current Characteristics:

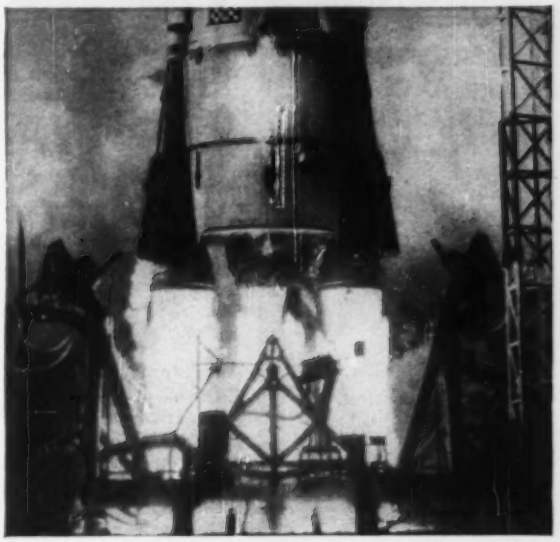


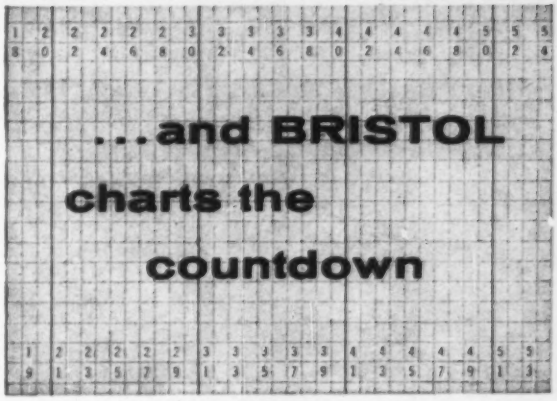
STEADY-STATE VOLTAGE-CURRENT CHARACTERISTICS OF FENWAL ELECTRONICS BA65V1

If a very small voltage is applied to a thermistor, a small current will flow which does not produce enough heat in the thermistor to heat it measurably above its surroundings. Under these circumstances, Ohm's Law will be followed and the current will be proportional to the applied voltage. However, if the voltage is gradually increased, the current will increase, and the heat generated in the thermistor will finally begin to raise its temperature above that of its surroundings. The resistance will consequently be lowered and more current will flow than if the resistance had remained constant . . . (3) Current-Time Characteristics . . . (*From new 24-page Bulletin EMC-4, Fenwal Electronics, Inc., 51 Mellen St., Framingham, Mass.*)

FOR THIS LITERATURE CIRCLE 174 ON READER-SERVICE CARD

ATLAS AWAY!





Bristol charts (sample above) in specially built "time and event recorders" at Vandenberg Air Force Base tell engineers vital facts about the critical moments in the countdown and first few minutes of flight of each Atlas missile.

Printed for Convair (Astronautics) Division of General Dynamics Corporation, prime contractor for the Atlas missile, these charts are just one example of the hundreds of "specials" turned out every year at Bristol chart printing facilities—one of the largest, most complete plants of its kind in the country.

Strip charts up to 32" across, circular charts to 12" diameter can be handled. Standard chart papers of highest quality are available. Or, Bristol can print on a wide variety of special papers, such as papers for metallic marking, foil-type laminates, card stock, heat- and pressure-sensitive, carbon-coated, or photo-sensitive oscillographic papers.

Get in touch with Bristol if you're designing a special recording instrument. An entire special chart engineering service is at your disposal. Or, for more information about this service, write for Bulletin Y1906. The Bristol Company, 154 Bristol Road, Waterbury 20, Conn. 0.29

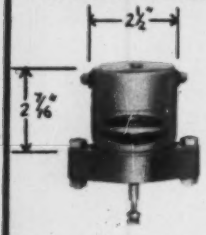
BRISTOL . . . for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 41 ON READER-SERVICE CARD

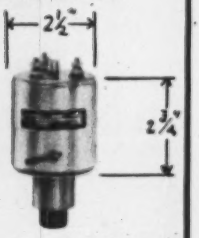
Synchro-Start

HEAVY DUTY D.C. SOLENOIDS



These solenoids are ruggedly constructed, having a life expectancy of over 2,000,000 operations at a rated capacity of 10 lbs. pull. They are available with ½, 1 and 1½ inch stroke.

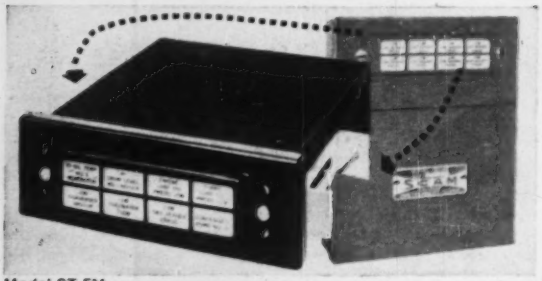
SPEED SENSITIVE SWITCHES



An extensive line of speed sensitive switches, with various mountings and drives to suit the needs. One or more snap switches contained in a single unit can be furnished to trip at any given speed with an adjustable range for each.

SYNCHRO-START PRODUCTS, INC.
8151 N. RIDGEWAY AVE., SKOKIE, ILL.

CIRCLE 42 ON READER-SERVICE CARD



Model ST-FM

Now—Automation Control You Can Depend On!

NEW SCAMMIT

STATIC-SWITCHING

MONITORING SYSTEMS

MODEL ST-AM

MODEL ST-EM

• Self-Contained • Lower Cost
• Range of Models and Sizes

Get greater reliability for all kinds of process and automation control with SCAMMIT MONITORING SYSTEMS. Permanent components and static switching reduce operational failure. Investigate dependable, economical SCAMMIT before you invest in any monitoring system.

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COMPLETE MONITORING SYSTEMS FOR INDUSTRY

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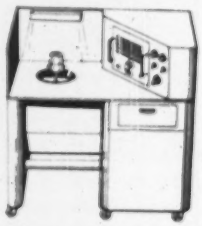
REPRESENTATIVES IN ALL PRINCIPAL CITIES

CIRCLE 43 ON READER-SERVICE CARD

ICS BRIEFS

Controlled Temperature Bath

Provided in this Console is a controlled bath for the calibration of thermostats, thermocouples, thermometers, thermistors, and other temperature sensitive

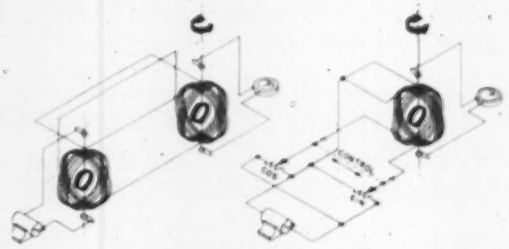


devices. The basic accuracy provided is 0.1°F; the range 0-100°F. The bath is controlled by electronically balancing heating and refrigeration elements . . . (*From new 8-page bulletin, Control Indicating Corp., Bradley Field, Windsor Locks, Conn.*)

FOR THIS LITERATURE CIRCLE 175 ON READER-SERVICE CARD

The Inductosyn

The operating principle of the Inductosyn may be understood by reference to the rotary form, which has an essential similarity to an electrical resolver or a selsyn or synchro. In all of these devices, the output signal as a function of rotation angle is obtained by the inductive coupling between stationary and moving conductors. The basic principle is well illustrated by

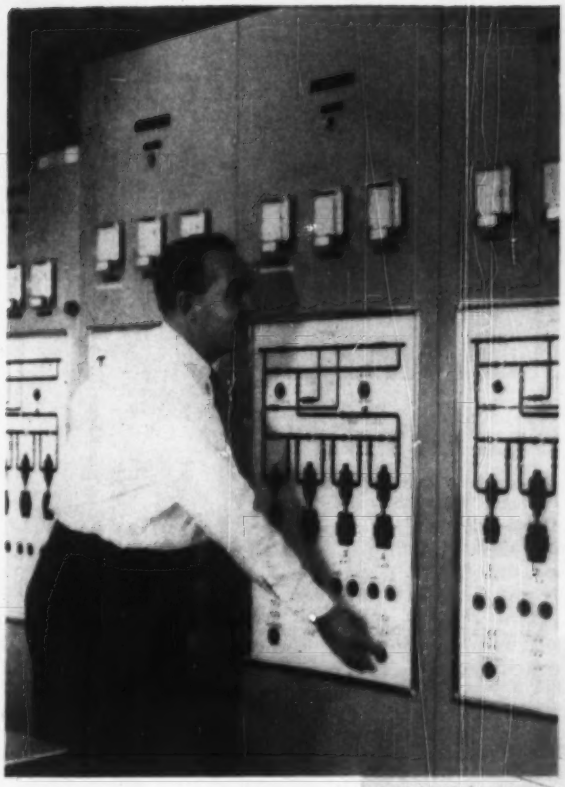


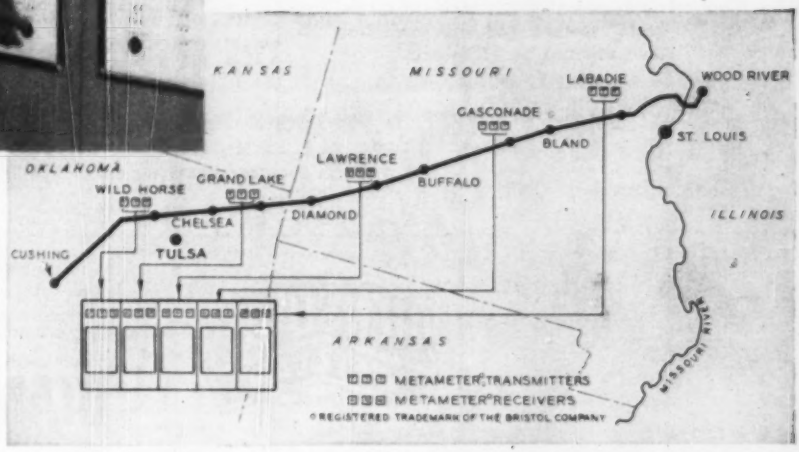
A B

the electromagnetic goniometer, illustrated. It consists of two stationary crossed coils and a third coil mounted on a rotating shaft. If two of these devices are paired and their stationary (stator) coils connected together as shown in (A) of Figure 3, they may be used as transmitter and receiver of angular data. If an a-c voltage is applied to the rotary coil (rotor) of the transmitter, a voltage maximum will appear at the rotary coil of the receiver when the two rotors are at the same angle with respect to their associated stators, and a voltage null will occur at ±90° from this position . . . (*From new 30-page Bulletin ER-312, Farrand Controls, Inc., 4401 Bronx Blvd., New York 70, N. Y.*)

FOR THIS LITERATURE CIRCLE 176 ON READER-SERVICE CARD

Bristol telemetering "mans" half the stations on 400-mile crude oil pipeline





Miniature Bristol Metameter® Telemeter Recorders (top row) on central supervisory control panel at Cushing office of Shell Pipe Line Corporation. Instruments, occupying only 5″ x 5¼″ on panel, indicate and make permanent record of suction, case, and discharge pressure at each of five unmanned stations along 400-mile pipe line. (See map.)

Bristol Metameter® system permits efficient, instantaneous supervision from central office, frees valuable personnel from routine duties.

Midcontinent Division of Shell Pipe Line Corporation, Houston, Texas, uses a Bristol Metameter System for telemetering on the Ozark Pipe Line System, a 400-mile pipe line from Cushing, Oklahoma, to Wood River, Illinois. This system is jointly owned by Shell Pipe Line Corporation and The Texas Pipe Line Company and is operated by Shell Pipe Line.

The Bristol Metameter telemetering system brings pressure readings from five unmanned pumping stations (out of 10 stations in all) along the pipe line into the central dispatching office in Cushing, Oklahoma. (See map.) Using the telemetered readings, the Cushing office can exercise complete supervisory control over pump operation at the unattended stations. Every other station along the line is manned, including the junction point, Cushing, and the terminus at Wood River. This puts personnel within a reasonable distance to take corrective action if trouble develops.

Whether they're used on oil pipe lines, natural gas pipe lines or distribution systems, electric power systems, water plants, or in steel mills or other industrial plants, Bristol telemeters can practically always improve operating efficiency and cut costs. Their accurate, precise readings are transmitted with the speed of radio (VHF, UHF, microwave), or telephone or carrier current lines for distances that may vary from a few yards to hundreds of miles. Pressure, liquid level, flow (including total corrected flow), temperature, mechanical motion, voltage, current, and power are just a few of the variables that can be transmitted.

Bristol developments in industrial telemetering, soundly based on more than 45 years' experience in this field, are making possible today a speed and an effectiveness in central supervisory control that would have been undreamed of only a few years ago. Let us give you full details. Write: The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

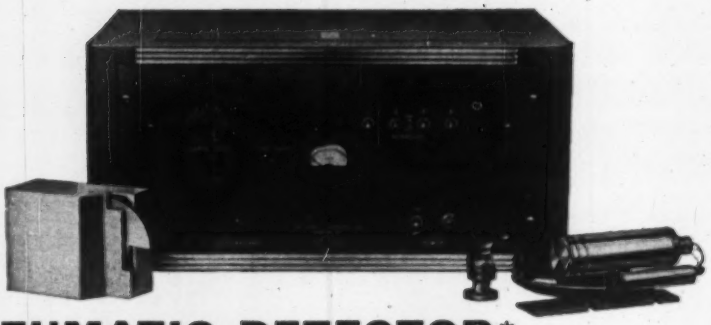
*T. M. Reg. U. S. Pat. Off. 0-19

BRISTOL ... for improved production through measurement and control

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

CIRCLE 44 ON READER-SERVICE CARD

A Superior Detector for Infra-Red Spectroscopy



GOLAY PNEUMATIC DETECTOR*

Among the characteristics that render the Golay Detector superior to other types of detectors for use in infra-red spectroscopy are:

1. **An effective sensitive area 3/32" in diameter.**
2. **Sensitivity of 6 x 10^{-11} watts RMS-ENI when used with "chopped beam" method and with recording time constant of 1.6 second.**
3. **Uniform sensitivity from the ultra-violet through the visible and the entire infra-red, and up to the microwave region.**
4. **Improved, drift-free. A. C. operated amplifier with step gain controls and four response periods.**

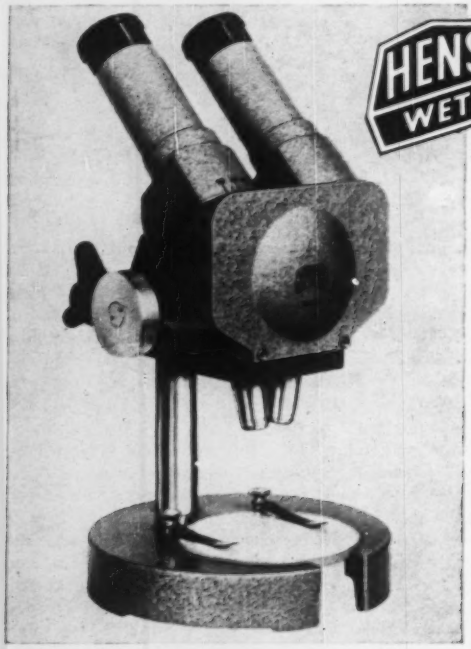
Write for EPLAB Bulletin No. 10

*Fundamental and experimental aspects of this detector are discussed in the following publications: Rev. Sci. Inst. *18*, 347 and 357 ('47); ibid. *20*, 816 ('49); Proc. IRE *40*, 1161 ('52).

278-8

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
2 Sheffield Ave. • Newport • Rhode Island • U.S.A.

CIRCLE 45 ON READER-SERVICE CARD



HENSOLDT WETZLAR

"DIAMAL" II STEREO-MICROSCOPE

3.3x to 80x

The high optical efficiency and compactness of this fine instrument make it ideal for the shop, inspection room or the laboratory.

The parallel inclined eye-pieces afford strainless three-dimensional vision. And its range of magnifications is exceptional in a stereoscopic instrument.

Interchangeable optical systems for magnifications from 3.3x to 80x are available. Also four different types of stands suitable for transmitted or reflected light, various reflected light illuminants, etc.

HENSOLDT QUALITY

The "Diamal" II is representative of the fine optical quality for which Hensoldt of West Germany has been noted since 1852.

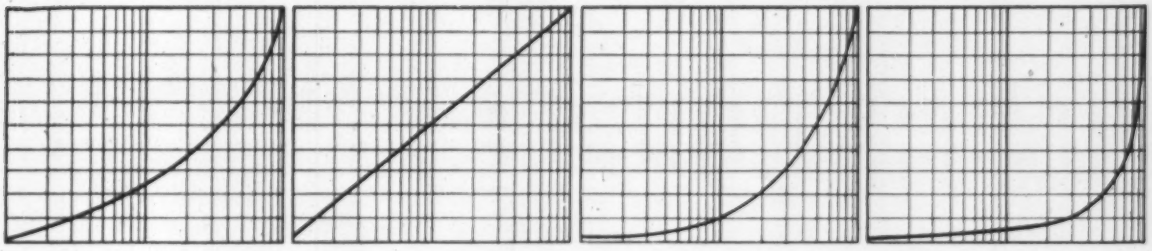
MADE IN WEST GERMANY

Write for detailed literature

COMPLETE SERVICE FACILITIES

CARL ZEISS, INC.
485 FIFTH AVENUE, NEW YORK 17, N. Y.

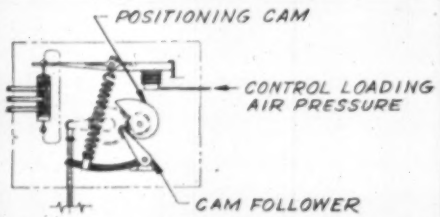
CIRCLE 46 ON READER-SERVICE CARD



TAKE YOUR CHOICE!

ANY OF THESE (and many more) CHARACTERISTICS ARE OBTAINABLE with DeZurik CONTROL VALVES

WITHOUT DISMANTLING THE VALVE!

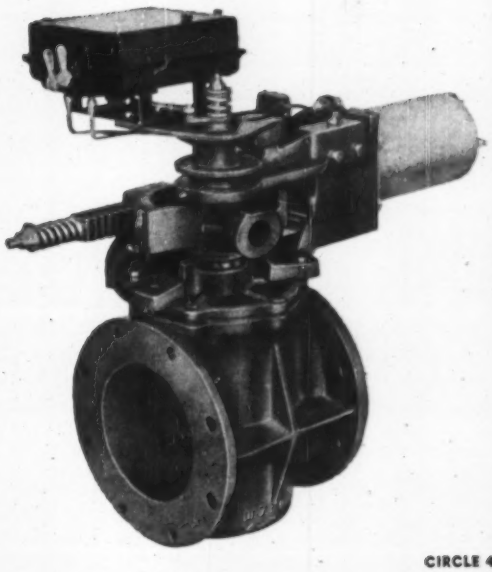


The positioning cam in the positioner is easily changed to vary the throttling characteristic. Cams can be supplied to produce virtually any desired curve, or they can be cut "on the job" to produce a characteristic tailored to the installation.

DeZurik Control Valves present an endless variety of possibilities to the instrument engineer. The characterizing feature of the positioner allows various positioning cams to be used which will produce almost any desired throttling characteristic.

The throttling characteristic may be pre-selected and the proper cam supplied with the valve from the factory, or the cam shape and resultant flow curve may be determined after installation of the valve. Changing cams is a simple operation and does not involve changing any valve part.

DeZurik Control Valves have extremely high rangeability, providing a wider control range than is available with ordinary control valves. Because of the port design and eccentric action, the flow characteristic is usable down to the shut off position.



In addition to this feature, DeZurik Control Valves offer dead-tight shut-off, higher capacity, leak-proof rotary stem seals, straight-thru flow and many other desirable features.

AVAILABLE NOW! GET THE COMPLETE STORY on DeZurik Control Valves. Ask the DeZurik representative in your area for Bulletin 150, or write Dept. CV.

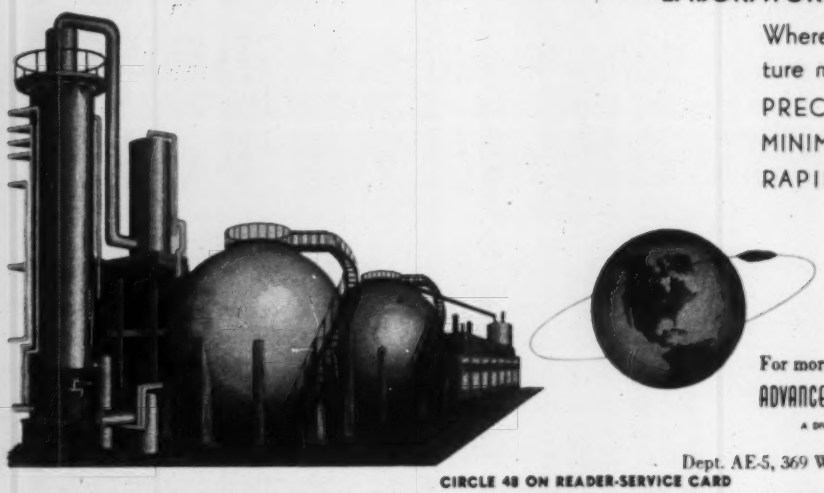
DeZURIK CORPORATION
SARTELL, MINNESOTA

CIRCLE 47 ON READER-SERVICE CARD

DELTA-COUPLES

THERMOCOUPLES FOR PROCESS INDUSTRIES
MISSILE & ROCKET DEVELOPMENT
LABORATORIES

Wherever surface and inwall temperature measurements are required with:
PRECISE JUNCTION LOCATION
MINIMUM HEAT FLUX DISTORTION
RAPID-ACCURATE RESPONSE



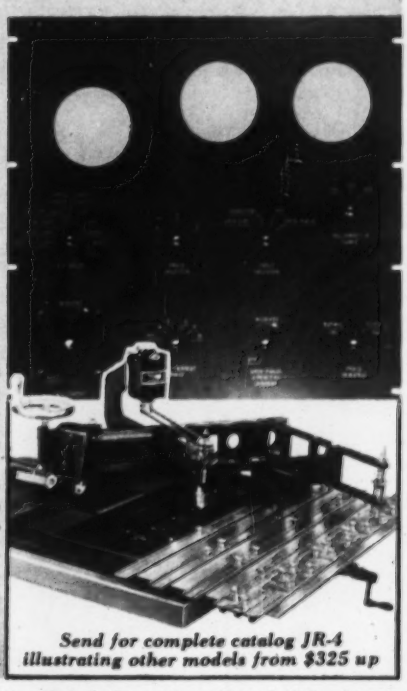
For more information, write to:
ADVANCED *Technology* LABORATORIES
A DIVISION OF AMERICAN-Standard

Dept. AE-5, 369 Whisman Road, Mountain View, California

CIRCLE 48 ON READER-SERVICE CARD

any size panels

engraved in your own plant



Engrave 1-inch nameplates or 6-foot panels by unskilled labor.

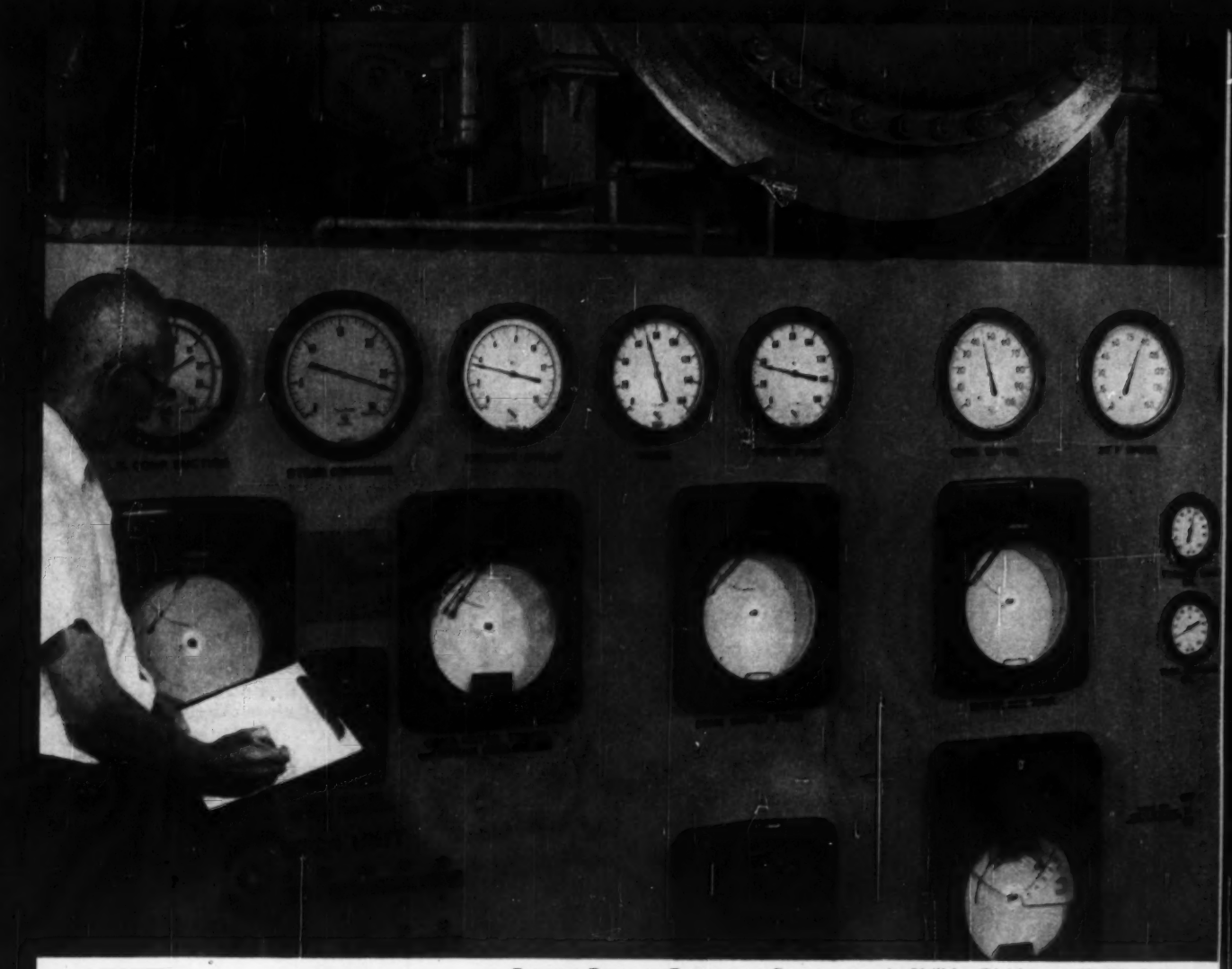
Spindle covers 18¼" x 6" in one set-up — more than any other machine of its kind.

Bench type model I-R — $685.

Send for complete catalog JR-4 illustrating other models from $325 up

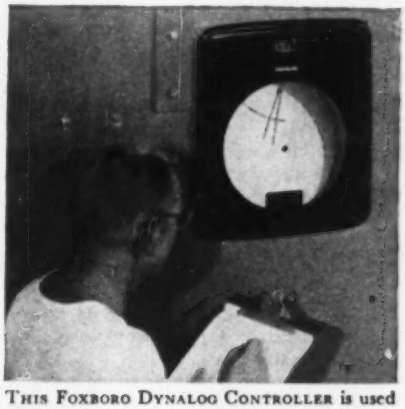
new hermes *Engraving Machine Corp., 154 West 14th St., New York 11, N. Y.*

CIRCLE 49 ON READER-SERVICE CARD



FOXBORO DYNALOG ELECTRONIC CONTROLLERS in Utilities Division, at Kodak Park, Rochester, N. Y. control distribution of refrigerated water throughout Kodak Park Works.

motor load – conductivity – pH – capacitance... Eastman Kodak uses Foxboro Electronic Dynalogs for dependable measurement and control



THIS FOXBORO DYNALOG CONTROLLER is used with a 1/10-inch Foxboro Magnetic Flow Meter to control flow of an additive to Kodak's paper machines at 0.1 gpm.

One basic instrument measuring and controlling these and dozens of other different variables: temperature, weight, moisture, conductivity, pAg, flow, humidity, That's what Foxboro Dynalog* Electronic Instruments do at Kodak Park Works in Rochester, N. Y.

And they're doing it without need for periodic maintenance. That's because Dynalogs have no slidewires — no balancing motors — no galvanometers. There's nothing to wear out or get out of alignment — nothing to lubricate. And simple unit construction makes changes in both type and range of measurement possible in the field — quickly and without affecting accuracy.

Ask your Foxboro Field Engineer to show you the savings possible when you standardize on Dynalog instruments. Or write for Bulletin 20-10. It has full details. The Foxboro Company, 4612 Neponset Ave., Foxboro, Mass.

*Reg. U.S. Pat. Off.

FOXBORO

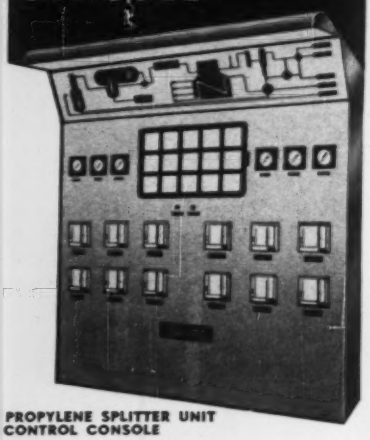
REG. U.S. PAT. OFF.

CIRCLE 50 ON READER-SERVICE CARD

Electro-Mech

ANOTHER ELECTRO-MECH FIRST:

VIS-A-SYSTEM INTEGRATED CONTROL CONSOLE



PROPYLENE SPLITTER UNIT CONTROL CONSOLE

VISUALLY AND FUNCTIONALLY INTERLOCKED:

• GRAPHIC PROCESS DISPLAY • ANNUNCIATION EQUIPMENT • INSTRUMENTATION • CONTROL ELEMENTS

With this control console, Electro-Mech Corporation introduces what is literally a new dimension to control-panel design. Here for the first time is realization of complete **integration** of all functional aspects of the control console.

We welcome your inquiries regarding the **VIS-A-SYSTEM®** Integrated Control Console and invite you to request an Electro-Mech quotation on your next Control Systems requirement.

Electro-Mech Corp., Norwood, N. J.

Electro-Mech

CIRCLE 51 ON READER-SERVICE CARD

ICS PANHANDLE PETE

WESCO! Line of Electronic Automation Equipments

WESCO!, pioneer automation firm, offers a new line of automation equipments that will solve mankind's basic problems:

1. Automatic editing equipments.

This line of automatic equipment will prepare manuscripts for publication, including automatic abstracting of all material written by scientists and engineers. It is well known that such manuscripts are practically unintelligible today. The WESCO! ELECTRONIC EDITOR will first abstract the manuscript. It does this by scanning the words and picking out the important ones. This is done according to the following formula:

Word Importance = (No. of Syllables) times (Generic Value) times (Interest Value).

For generic value, Greek words have an index of 10, Latin words 5, French words 2, German words 25, Russian words 450, English words 0.2.

For interest value, a table of words is prepared in advance by the programmar. For example, "systems engineering" has an interest value of 100; reliability 85; computer control 675; automatic control 79; measurement 0.2; use of basic electrical instruments 0.5; theory and math 84; calibration techniques 0.6.

After the abstract, statistical techniques are used to evaluate the important passages, which are then automatically typed on high-speed typewriter for the printer, with all words simultaneously entered on microfilm and magnetic tape for machine search and retrieval.

2. Automatic retrieval.

In this technique the Automatic Editor automatically codes every technical word and prepares the code for machine search. For example, every time the word "meter" is used, the code (0111000011001100—OP 4—0010) is used and entered on magnetic tape.

Thus anybody looking for a "meter" can search the world's literature for every reference to the word. One search will require only 2.6 hours of machine time.

Machine will rent for $76,000/hr, but when every engineer learns to make a machine search before entering a research project, duplication of effort by scientists will be eliminated, saving $42 billion annually. Machine will thus have a payoff period of 0.006 second if 36,472 men make the same search.

3. Automatic writing.

Every engineer knows what a chore it is to write reports and articles detailing his work. This is one of the most onerous tasks facing an engineer. The WESCO! ELECTRONIC EDITOR will eliminate this chore. Every day, the engineer will feed his notes to the electronic editor, which will use the same techniques mentioned to code, abstract, and prepare the work for both printing and abstracting and machine retrieval.

4. Automatic Coding.

It is expected that the world's technical literature can be so coded in 8-10 years, with proper governmental support. Only $7.6 billion will be required.

5. Automatic reading.

When the new WESCO! techniques are in full use, it will not be necessary for any engineer or scientist (or anybody else) to read, freeing every man for productive tasks. The WESCO! AUTOMATIC EDITOR will take the man's problem, code it for machine search, make the search, and type out the answers. With proper coding, the machine will also solve the problem. It will no longer be necessary for men to read anything of a technical nature. Humanity will thus have time for reflection and prayer, which leads to:

6. WESCO! line of Religious Automation equipments

A complete line of automated "Dial-A-Prayer" prayers will be offered from 10-second hail heaven and hallelujah shorties ($1 each) to 5-minute devotionals ($10 each). Periods of devout silence are offered at a rate of 10 cents per second. All that is needed to obtain a prayer is a telephone call to the central religious facility—all else is completely automatic (including billing) as tape-recorded programs will be controlled by preset coded cards.

Panhandle Pete

BOOK REVIEWS

Advances in Astronautical Sciences, Vol. 4, distributed by Plenum Press, Inc., 227 West 17th St., New York 11, N. Y., 459 p., 10″ clothbound $8.00. Volume represents Proceedings of the Fifth Annual Meeting of the American Astronautical Society.

Graphic Aids to Frequency Response Study and Feedback Control Systems published by Boonshaft and Fuchs Inc., Hatboro Industrial Park, Hatboro, Penna., 11″, paperbound $5.00. Workbook contains a comprehensive set of graphs of linear transfer functions and nonlinear describing functions. Also 50 transparent Nichols Charts are provided for plotting on the linear terms.

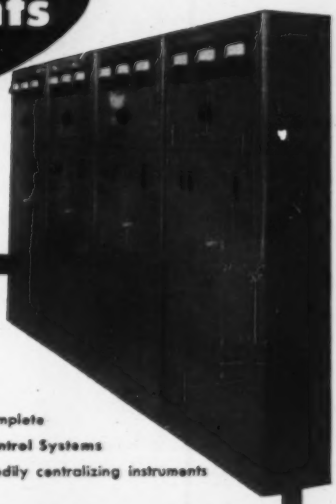
Apparatus Drawings Project (ADP), edited by Robert C. Marcley, Plenum Press, Inc., 227 West 17th St., New York 11, N. Y., 50 sheets, 17½″ storage case, $40.00 total price. First 10 reports for Volume 1 (which will contain 30 reports) with complete data and drawings of unique and economical pieces of apparatus developed in the physics laboratories of America's leading colleges and universities, printed on flat sheets (11″ x 17″ one side). New concept in the communication of equipment design. When subscribers have received the complete set of reports, a clothbound book will be sent to them containing all the material in handy reference form for a desk or library.

Book Computer, by Kirk Finley Carlsten and Karsten Gene Hellebust, [c 1960] Metron Instrument Co., 432 Lincoln St., Denver 4, Colo., 910 pp., 10″, clothbound $15.00. Prepared on a digital computer, tables in book multiply and divide whole numbers to six significant figures and produces the desired information at an average of five times faster than logarithm tables. The square and cube roots, reciprocal, logarithm to the base 10, etc. are indicated.

Digital Applications of Magnetic Devices, edited by Albert J. Meyerhoff and staff, [c 1960] John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 604 pp., 9″, clothbound $14.00. Provides necessary theory for the design of the major digital magnetic circuit types and examples of several specific systems.

Apart from a full line of Temperature CONTROLLERS

users have proved *these* instruments by WEST



MODEL | SERIES
High Resistance indicating pyrometers

Complete Control Systems handily centralizing instruments

MODEL RT SERIES
Resistance Thermometer indicators (and controllers)

MODEL IE SERIES
Portable high resistance indicators

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Multi-Point indicators with TC switches

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For data on these or controller instruments, use your classified phone directory or write direct.

the trend is to WEST

CIRCLE 52 ON READER-SERVICE CARD

The Important Difference In Digital Voltmeters...

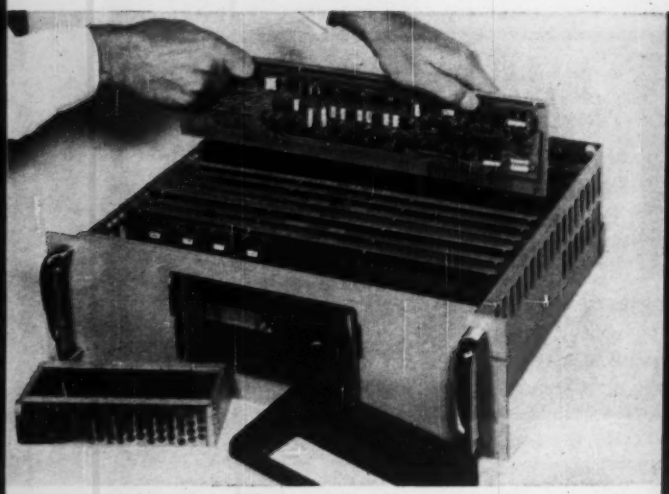
Check the design and construction features pictured here. These are the subtle marks of quality that exemplify the engineering leadership of NLS . . . the *important difference* between NLS digital voltmeters and those of other manufacturers. These are the engineering innovations that assure accuracy and rugged reliability . . . that minimize maintenance and downtime . . . that add to the long-term efficiency and usefulness of NLS instruments. Yes, there's more to a digital voltmeter than meets the eye . . . so look behind the front panel and beyond the specification sheet before you buy! Call on your NLS representative to demonstrate the instrument of your choice . . . to show what engineering leadership means to you in digital voltmeter performance and usefulness. Write today for the NLS catalog that describes the world's most complete line of digital voltmeters . . . by purpose, by price!

Originator of the Digital Voltmeter

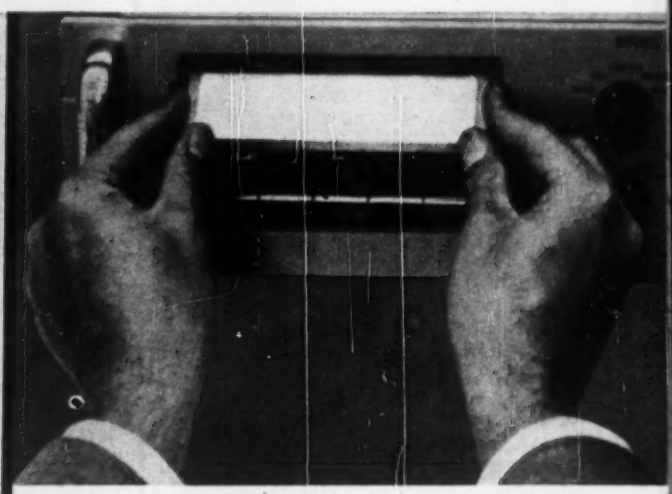
non-linear systems, inc.

DEL MAR, CALIFORNIA

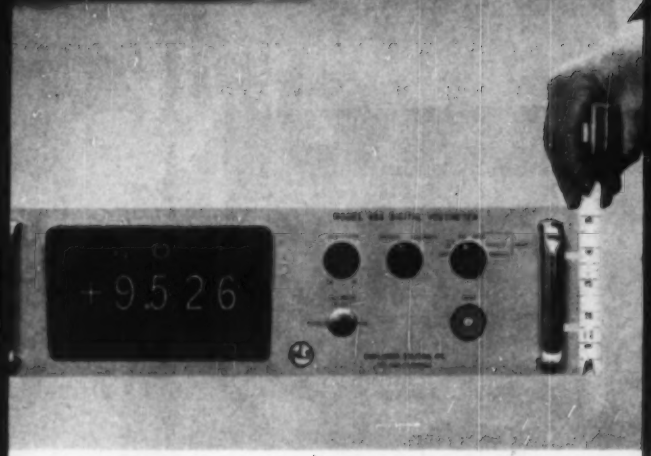
CIRCLE 148 ON READER-SERVICE CARD



1 **PLUG-IN MODULAR CONSTRUCTION** *simplifies servicing, drastically reduces maintenance costs, keeps instruments on the job. More than 99% of the components of the NLS V44, Series 20 and Series 30 instruments are mounted on plug-in modules.*

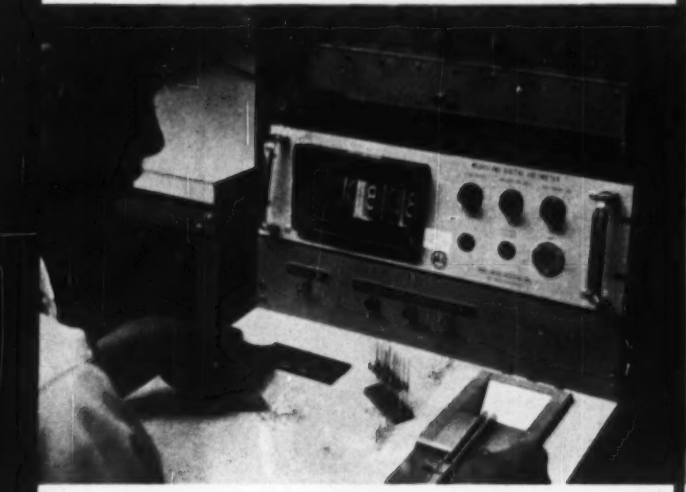


2 **SNAP-OUT READOUT,** *exclusive on all NLS digital instruments, permits 20-second bulb replacement through front panel without tools. Precisely engraved readout numerals can be read all day from close up or far away without eye fatigue.*

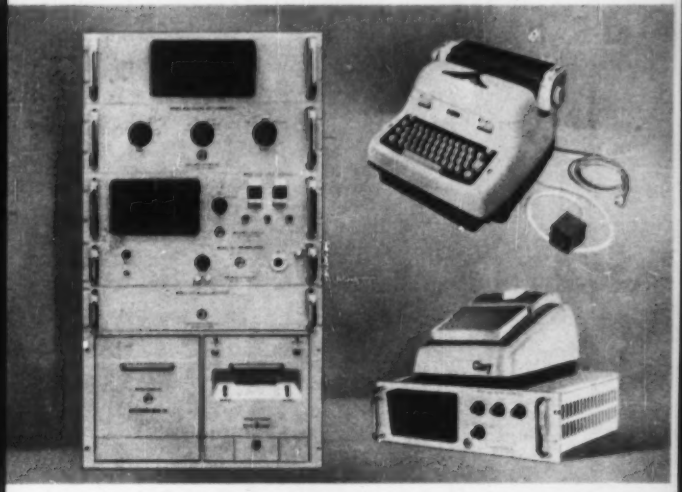


3 **COMPACT DESIGN** — *illustrated by the 5¼"-high NLS 484 DVM, complete with recording controls – is one of the more obvious clues to superior engineering. Even the lowest cost NLS instruments are more compact with fewer cables and connections. Result: greater reliability.*

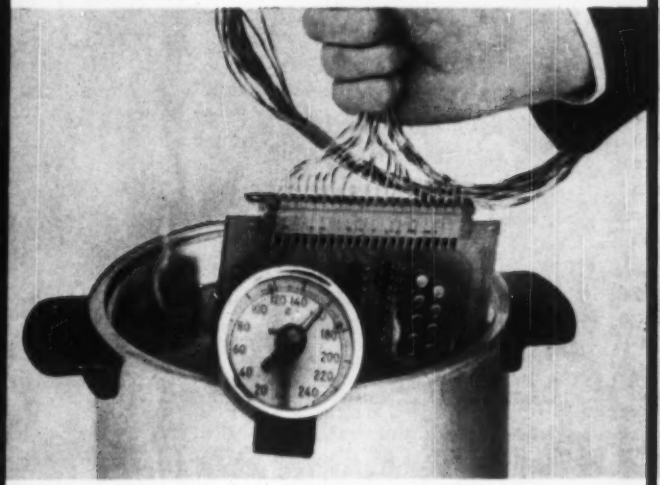
4 **"NO-NEEDLESS-NINES" LOGIC** *in Series 30 results from a new concept in transistor logic which eliminates unnecessary, time-consuming cycling of stepping switches through their 9's and 0's positions. This increases accuracy, speed, reliability and usefulness, particularly in systems applications.*



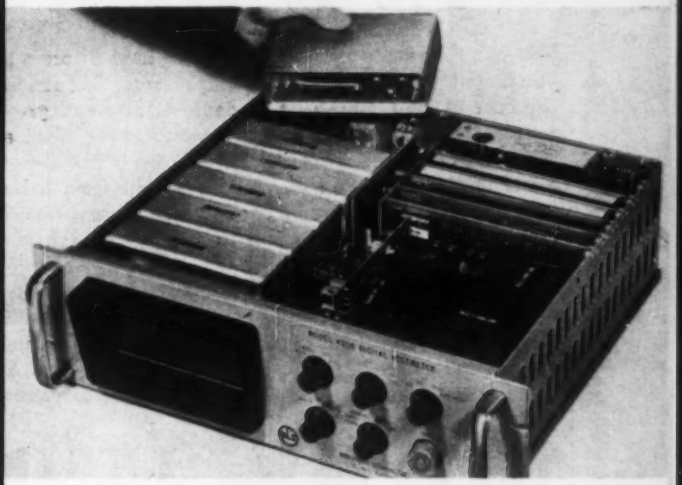
5 **FULLY AUTOMATIC OPERATION,** *pioneered by NLS, includes automatic selection and indication of range and polarity. Human error is virtually eliminated.*



6 **PLUG-IN ACCESSORIES** *can be mated in minutes with an NLS digital voltmeter to form hundreds of combinations. These include AC/DC converters, preamplifiers, input scanners, and virtually every type of data recorder.*



7 **"NO POTS AT ALL" STABILITY** *of the NLS V44 DVM is checked by the "boil in oil" test at 158°F. This feature eliminates all trimming of decade and amplifier circuits.*



8 **PLUG-IN OIL-BATH STEPPING SWITCHES** *in Series 30 instruments outlast dry switches by a factor of five . . . completely eliminate periodic disassembly for manual lubrication of switches.*

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
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HAPPY NEW YEAR!

The clock in the corner of this page indicates that 396 copies of *INSTRUMENTS AND CONTROL SYSTEMS* (formerly *INSTRUMENTS*) have reached our readers, totalling 33 years of service to users of measurement and control devices.

Our proudest accomplishments are our basic studies of the several fields of instrumentation, many of which now are available as books and handbooks. The books include:

- Process Control
- Process Control Analysis
- Control Valves
- Regulators and Relief Valves
- Strain Gage Instrumentation
- Digital Techniques for Computation and Control
- Weight Measurement and Control
- Magnetic Tape Instrumentation
- Nuclear Reactors for Industry and Universities
- 100 Electronic Circuits (Vols. 1 and 2)
- Electronic Circuitry for Instruments & Equipment

Series of articles have been presented on

- Electrical Measurements
- Computer Techniques
- Temperature Measurement and Control
- Flow Measurement and Control
- Metrology and Motion (Velocity, Acceleration, Vibration)
- Timing Techniques
- Symbolic Logic

For 1961 your editors have exciting plans for you. As in the past, each issue will present a series on one phase of instrumentation, while continuing the several monthly features in process flow control systems and flow instrumentation, digital techniques, analog computers, electronic circuits, etc. On the front cover of this issue are reproduced the covers of the twelve issues during 1961. The month-by-month emphasis will be:

- **January**—Electrical Measurements
- **February**—Pressure Instrumentation
- **March**—Programming, Timing and Optical Instrumentation
- **April**—Flow Measurement and Control
- **May**—Temperature Measurement and Control
- **June**—Telemetering
- **July**—Recording
- **August**—System and Data Instrumentation
- **September**—Numerical Control
- **October**—Process Instrumentation, with emphasis on valves
- **November**—Analytical Instrumentation and Stream Control
- **December**—Current and Voltage Control

The articles in January will include:

- Selecting a Potentiometer
- Calibration-Consoles
- Electrical Standards at GE
- Electrical Standards at Kearfott
- 3-Terminal and 4-Terminal Measurements
- The Iso-Ohmic Voltage Divider
- The Transformer Bridge
- The Schering Bridge
- Phase-Shift Measurements
- Instrument Accuracies
- Standards Laboratories of Other Countries

PLUS—each issue also will include feature articles in our regular monthly features:

- **Digital Techniques**—an entire series on data storage devices (begins in this issue)
- **Process Control Systems**—four or five each month.
- **Electronic Circuitry**—four or five complete circuits each month.
- **Simulation Council Newsletter**—in every issue, reports of the technical society for analog computer users.
- **SCMA Journal**—Process articles presented at meetings of the Southern California Meter Association (one per issue).
- **New Applications**—a special section on measurement and control equipment.
- **New Products**—about 70 or 80 per issue, selected and carefully edited.
- **New Literature**—about 1000 pieces, indexed by subject, reported each year.

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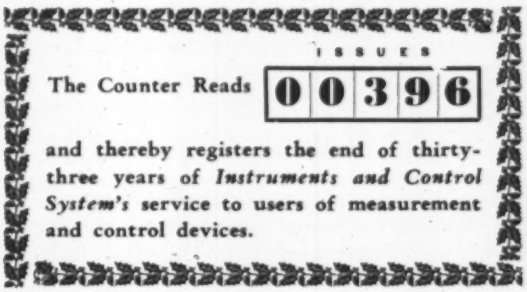
ISSUES
The Counter Reads
00396
and thereby registers the end of thirty-three years of *Instruments and Control System's* service to users of measurement and control devices.

Continued from page 2061

- **Briefs**—principles of operation with schematics and diagrams (10-15 per issue).
- **Trends**—brief comments on the latest news and developments in the field.
- **Stock Market Report**—monthly recap of stock quotations on listed instrument and allied manufacturers, including "over the counter" sales.
- **Instruments and Control Systems Buyers' Guide** will again appear as Part II of the October issue. This Buyers' Guide is the only guide in the field of instrumentation and automatic control. The products of over 2500 companies are indexed in the last **Buyers' Guide**, just published.

And SOMETHING NEW will be added—the **JOURNAL OF THE PRECISION MEASUREMENTS ASSOCIATION.**

PRECISION MEASUREMENTS ASSOCIATION

The Precision Measurements Association comprises several hundred men, most of whom are located in the Southern California area. (Sections are being organized in other areas where there is a heavy concentration of work in precision measurements.*) The objectives of the PMA are:

a. *To promote unity and effectiveness of effort among all those who are devoting themselves to high accuracy measurement.*
b. *To provide necessary and convenient facilities for the holding of meetings of the Association.*
c. *To provide for reading, publication and distribution of papers and publications of the Association.*
d. *To provide for sub-groups of special interests within the scope of the organization.*
e. *To encourage the establishment and acceptance of a common terminology relative to precision measurement.*
f. *To engage in any other activities which are, or shall be not inconsistent with, contrary to, or prohibited by law, if such activities are necessary to, or convenient for, the accomplishment of the aims of the Association.*

The meetings of the PMA are devoted to the subject of precision measurements, which includes standards, calibration, and high-accuracy measurements in the basic fields of electrical measurements, dimensional gaging, weighing, pressure, force, etc. The emphasis is on standards and calibration, a field which is becoming of greater importance daily.

INSTRUMENTS & CONTROL SYSTEMS anticipated and recognized the field of precision measurements with several basic series of articles on electrical standards, weight standards, and dimensional and motion standards, which series ran through 1958, 1959, and 1960. It is in recognition for this work that the Precision Measurements Association has decided to publish its Journal in *INSTRUMENTS & CONTROL SYSTEMS*. Welcome aboard, PMA.

*If you are interested write to the secretary of PMA.

The officers, directors and committee chairmen of the PMA for the year 1960-61:

OFFICERS

Pres. .....WILLIAM K. GEIST
W. K. Geist Co., Los Angeles, Calif.
V. Pres. .....HOWARD KEMP
Borg-Warner Controls, Santa Ana, Calif.
Secty. .....FRANK TOMA
General Radio, Los Angeles, Calif.
Treas. .....A. K. EDGERTON
Western Instruments, Burbank, Calif.

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Douglas Aircraft, Long Beach, Calif.

Publicity:
JOHN FOSTER
International Electronic Research, Burbank, Calif.

Employment:
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Delta Instruments, Los Angeles, Calif.

Education:
ED McINTOSH
Delta Instruments, Los Angeles, Calif.

Publications Chairman:
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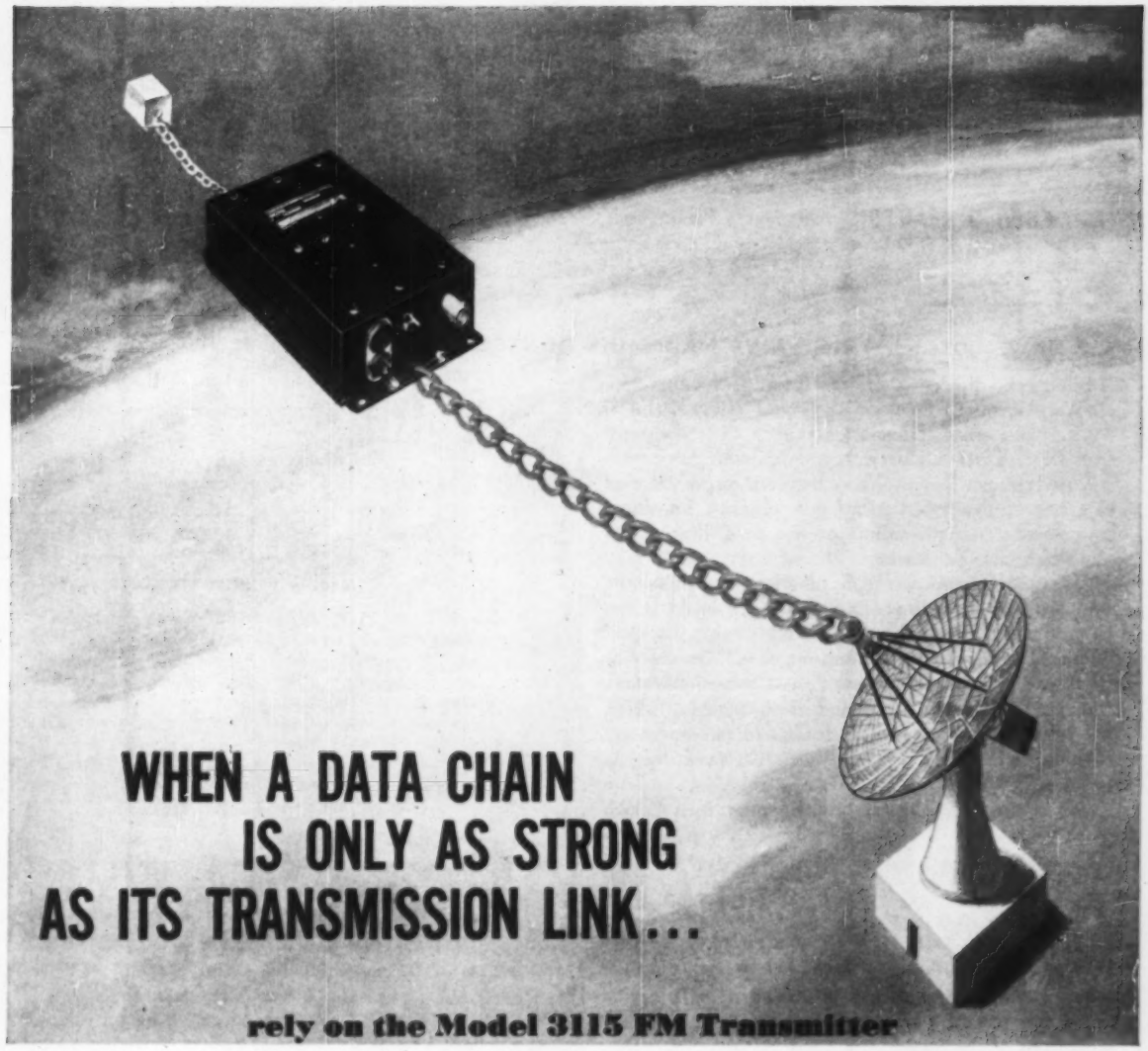
R.C.A., Van Nuys, Calif.

C. C. CATHERMAN
Hughes, El Segundo

PMA Meeting Announcement

Dr. Forest Klaire Harris from the National Bureau of Standards will be the guest speaker at the January 4th meeting of the Precision Measurements Association. Anyone interested in the field of Metrology is cordially invited. Dr. Harris is an eminent authority on electronic standards and is now Professorial Lecturer at George Washington University. He has been with NBS since 1923 and is the author of **Electrical Measurements** and many other widely read publications. Dr. Harris will speak on "The Status of Electrical Standards."

Nonmembers can contact the P. M. A. Office at 826 North Victory Boulevard, Burbank, California, Telephone, VI 9-3013, to make reservations prior to December 16. The dinner meeting will be held at Michaels Restaurant (Washington Boulevard and Santa Ana Freeway), starting at 7:00 p.m.—Dinner, $3.75.



WHEN A DATA CHAIN IS ONLY AS STRONG AS ITS TRANSMISSION LINK...

rely on the Model 3115 FM Transmitter

When radio telemetry transmission is the link between airborne data gathering and ground data acquisition, rely on Radiation's Model 3115 FM Transmitter. This ruggedized unit has proved its reliability and dependability again and again in missile projects and on test sleds.

Model 3115 provides true linear FM output. Modulation frequency response is within 0.5 db from 100 to 100,000 cps, and carrier frequency stability is within $\pm 0.01\%$. RF power output is 2 watts. The unit is available in two crystal-controlled models, which cover the 215 to 260 mc telemetry band.

For more complete technical data on the Model 3115, write for a new bulletin, RAD B-102, to Radiation Incorporated, Dept. IC-12, Melbourne, Fla.

THE ELECTRONICS FIELD ALSO RELIES ON RADIATION FOR...

RADIPLEX—50-channel low-level multiplexer with broad data processing applications. Features rugged solid-state circuitry, almost unlimited programming flexibility, unique modular construction for compactness and exceptional ease of operation and maintenance.

RADICORDER—Multistylus recorder provides high-speed instantaneous readout for wide range of data acquisition or processing systems. Eliminates necessity of electronically translating complete data, thereby reduces computer work loads.

TDMS—Telegraph Distortion Monitoring System pinpoints type and source of trouble on teletype, data processing and similar communications links without interrupting traffic. Ultra-compact TDMS can replace most test equipment now required for teletype maintenance and monitoring.

RADIATION INCORPORATED

CIRCLE 54 ON READER-SERVICE CARD

Process Control Systems

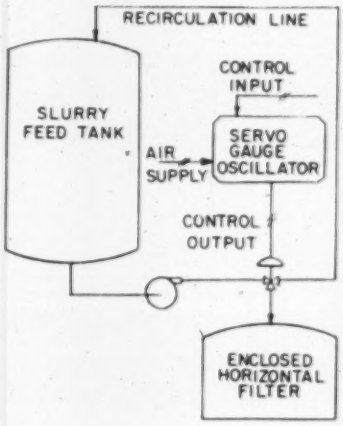
FRED D. MARTON, Instruments Publishing Company

OSCILLATING VALVE MAINTAINS CONSTANT HEAVY-SLURRY FLOW

Filter-cake thickness and uniformity required by Hooker Chemical Corporation in its Niagara Falls, N. Y. plant necessitated maintenance of a constant-feed flow of heavy slurry to a continuous horizontal enclosed filter. The problem involved prevention of clogging of the flow-regulating equipment by slurry components, and provision for the possibility of explosive vapors in the area.

The problem was solved by continually cycling the control valve, an air-operated, three-way valve. It has a contoured plug. The "ramrodding" of the port cleans out clogging crystalline deposits. The valve is operated by a pneumatic timer (servo gauge oscillator) which controls both the period of time during which the valve feeds slurry to the filter and the frequency of rodding out the valve feed port. The cycle time is adjustable from a few seconds to 3 minutes.

Source: Associated Control Equipment, Inc., Coraopolis, Penna.

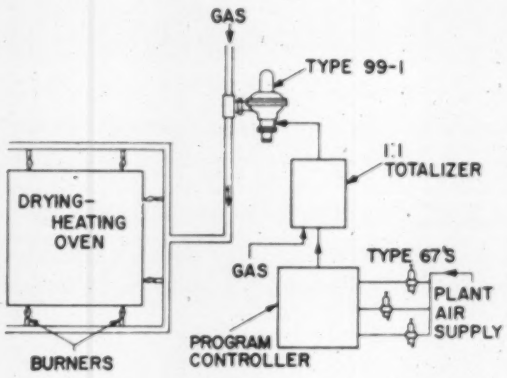


HOT-TOP DRYING OVEN SYSTEM

Hot top is the term for a structure used in the production of certain kinds of steel. The hot top put over an ingot mold prevents the formation of a "pipe," a defect on top of the ingot which is caused by the shrinkage of the metal. The hot top, made of a castable refractory, and having roughly the shape of the top of the ingot mold, floats on the molten steel when the mold is filled. As the steel in the mold cools faster than the steel in the hot top, molten metal runs down to fill any cavity. As a result, any "pipe" that forms will be in the hot top, providing an ingot free from this defect.

The hot top must be prepared for use by heating and drying to prevent explosion from steam formation and to reduce thermal shock to the refractory. The heating-drying operation is performed in a separate gas-fired oven in a cycle predetermined empirically.

A simple control system for the drying oven is illustrated. It utilizes a pilot-controlled pressure regulator (Type 99-1) in the gas line, which establishes the minimum pressure to the six sets of burners. Instrument-air-type regulators (Type 67) supply up to 4 different air pressures for loading the spring case of the pilot on the main regulator. A program controller switches the air pressures in established time intervals. A totalizer with a 1:1 ratio changes the air pressures into identical gas signals so as not to use air signals in the gas regulator, a safety feature. Thus, the rate of drying is varied by the program controller.

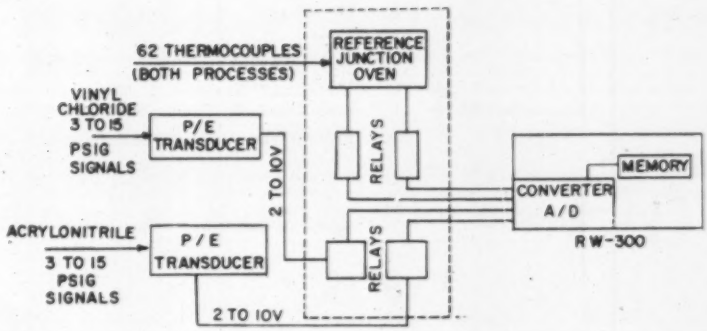


Equipment used: Type 99-1 pressure regulator; totalizer relay (any make); program controller (any make); and up to four air-pressure regulators, Type 67.

Source: Fisher Governor Co., Marshalltown, Iowa; also Application Bulletin, Form AB-403.

COMPUTER CONTROL OF VINYL CHLORIDE AND ACRYLONITRILE PROCESSES

B. F. Goodrich Chemical Company, Calvert City, Ky., is using one general-purpose control computer (RW-300) in control of two process reactions. One is a *vinyl chloride process* involving thermal pyrolysis of ethylene dichloride to vinyl chloride and hydrogen chloride. The second is an *acrylonitrile process*, a series of catalytic reactors, each with its own characteristics.



Operation is as follows: The first step is to run a check or test problem which checks the computer circuits and the complete analog-to-digital and digital-to-analog system.

If it passes this test, the program then reads a digital clock. Once it knows the time, it starts down its list of duties, arranged in order of priority:

Every 5 minutes (Starts on the hour)	Scan vinyl chloride process Scan acrylonitrile process
Every 20 minutes (Starts at 10 past the hour)	"20-minute" control equations
Every hour (On the hour)	Log vinyl chloride process Log acrylonitrile process
Every 8 hours (Initial time 00:05)	Vinyl chloride optimization calculation
Every 24 hours	Vinyl chloride daily log Acrylonitrile daily log

The *'twenty-minute" control* and *optimization* programs calculate the new control set-points, test them to see if they are logical, and store them. The *hourly logs* give a complete type-out of all variables, including calculated terms such as the reactor conversion and stream concentrations. All flows are hourly averages of the 5-minute scans, and the pressures and temperatures are instantaneous.

The *daily logs* give a rather complete engineering analysis of the day's operation. This includes totalized flows, efficiencies, and the new correlation constants that the adaptive parts of the math model have calculated. Both the hourly and daily logs use the appropriate logger, and the acrylonitrile announcements are made on the logger located in that process area.

Plant engineers can perform certain operations while the computer is doing its normal jobs. For example, they can make calculations on any one of four standard mass spectrometer analyses for an off-line mass spectrometer. This program obtains the solution of up to 29 sets of simultaneous equations. The answers are typed on the Flexowriter in mol % of each component, plus the average molecular weight. The 29 component analyses take 3½ minutes and fit fairly well between the 5-minute scans.

The "eight hour" optimization program is the basic starting point for control equations. Its objective is to calculate optimum conditions, including feed rate and conversion, for the pyrolysis reactor. In the present program this is done with the restraint of meeting and not exceeding a given monthly goal. This goal may be changed many times during the month, and the process itself introduces variations due to lost production. These changes and variations are taken care of automatically. At any time the computer can be given a new goal, although this does not necessarily mean that the process can make it.

This program utilizes kinetic coefficients for its predictions. These are subject to change due to uncontrollable feed stock purity variations. These kinetic coefficients also determine the size of certain corrections that are made to the reactor's instruments. They are automatically updated, based on the last hour of operations. In a sense then, the equations are "adaptive." The kinetic equation is actually expressed in the form of a multiple correlation.

$$C = b_o + b_1 f_1(T) + b_2 f_2(F) + b_3 f_3(P) \ldots b_n f_n(N)$$

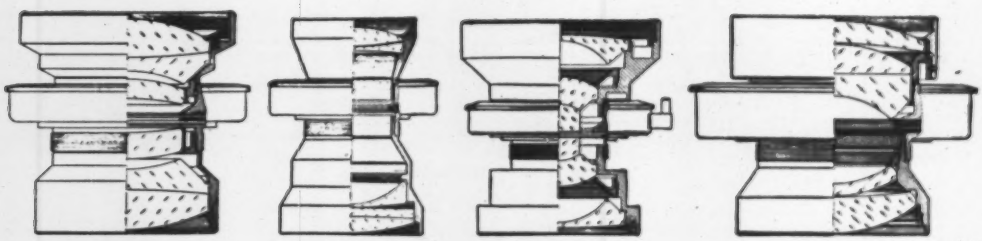
where C = Conversion, T = Temperature, P = Pressure, F = Flow Rate; b_o, b_1, b_2 . . . b_n are multiple correlation coefficients. Only b_o is presently updated on-line.

The other constants will be re-evaluated periodically by off-line computation.

The twenty-minute control equations work to maintain the optimum reactor conditions calculated by the eight-hour optimization. It also calculates the actual conversion from a group of plant physical readings. The equations work to adjust the reactor feed rate and heat input to maintain a constant conversion at the opimum value. The ambient conditions and feed impurities are the major uncontrolled variables which work to change the conversion.

In addition, the twenty-minute control program controls the operation of parts of the distillation train. On one column this is done through a rather complicated temperature profile control approach. Essentially, the computer calculates the feed composition from the conversion and flow measurements. From an analysis of various plate temperatures, it determines which way to adjust the temperature control setting at the control point, which is also on a column plate. The result is the maintenance of product with minimum losses.

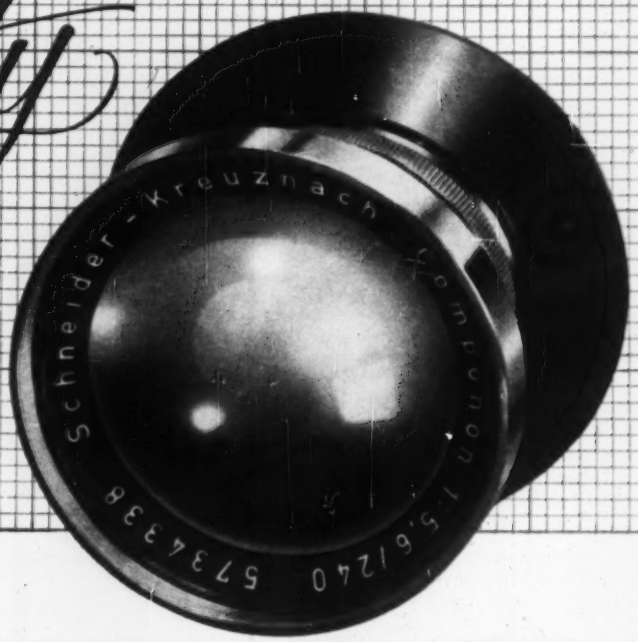
Source: B. F. Goodrich Chemical Co., Cleveland, Ohio; "Reports on Computer Control of Chemical Process."



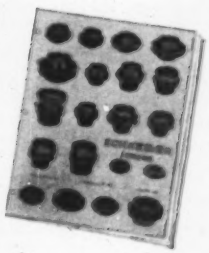
SYMMAR TELE-ARTON SUPER-ANGULON XENOTAR

For those with problems involving

Quality Optics



Whether your lens problem involves simple reproduction, or complex optical and electronic devices, it will pay you to check first with Schneider . . . world's leader in quality optics. For the Schneider line, *the world's most extensive*, includes close to 300 different lens types. More than likely, it includes the exact lens you require . . . or certainly one which can be modified to exactly meet your specifications. All are of highest quality available . . . the most modern electronically computed designs (including air spacing) . . . rare earth glasses with all surfaces coated. Yet, these lenses are available at realistic prices . . . another practical reason for you to investigate Schneider. Specification sheets are available giving dimensions, optical characteristics, nodal points, back focus, spectral transmission and relative illumination curves, etc. Literature on request.



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CIRCLE 104 ON READER-SERVICE CARD

THE PLANT INSTRUMENT DEPARTMENT

FELIX E. DANDOIS
Westvaco Chlor-Alkali Div.
Food Machinery and Chemical Corp.

Facilities and functions of a modern instrument department.

TWENTY-FIVE years ago we had no formal Instrument Department, and performed little instrument maintenance in our heavy chemical plant of approximately 1000 employees. Today we are doubling plant instrumentation every ten years. We have one instrument design engineer, two instrument foremen, 15 qualified instrument mechanics, and 3 instrument pipefitters. Half of our equipment is electronic, the other half pneumatic and other types.

Our objectives:

1. Routinely check and inspect instrumentation as required.
2. Install new or modify instrument system as required.
3. Train all instrument men to be familiar with all plant equipment.

Our plant covers 27 acres. It is divided into two production areas, plus a steam and power department. We have approximately 1500 major instruments. This does *not* include pressure gages, rotameters, pressure switches, timers, temperature switches, and flame protection devices. Note that we have one mechanic for every 100 major instruments. This is a pretty good rule of thumb to use when organizing new departments, or for those who wonder if their present number of mechanics is sufficient.

This figure may vary, however, if the over-all instrument picture is diversified. Instruments on clean services, such as water or natural gas, do not require as much attention as instruments on difficult, corrosive chemicals such as chlorine or caustic soda. The condition of one's plant air is significant on certain types of instruments.

Facilities

At Westvaco a comfortable, well lighted, well equipped instrument shop is provided for the proper maintenance of instruments. A separate work bench is provided for each mechanic. Each bench is equipped with an air supply, natural gas supply, vacuum line, and convenient electrical outlets. Proper test gauges, air regulators, and small hand tools are also provided each mechanic. There is a rotameter testing bench, a constant temperature bath for testing temperature instruments, a caustic bath for cleaning control valves, flow meters, a mercury cleaning table, grinding and buffing wheels, vises, and large tools for use by the entire department.

Presented at 11th Plant Maintenance and Engineering Show, Phila., Jan., 1960.

Electronic Instruments

We have a special partitioned area for the servicing of electronic instruments and the storage of test equipment. This isolated area allows us to work on, and perhaps leave overnight, delicate electronic equipment without the danger of breakage or tampering that might otherwise occur. Some of our major shop test equipment is given in Table 1.

No instrument department is complete without two other important facilities—a properly equipped foreman's office and a properly equipped stock room. The foreman's office should be totally inclosed so that disciplinary talks, interviews, etc., can be conducted in privacy. The foreman should have a good view of the entire shop.

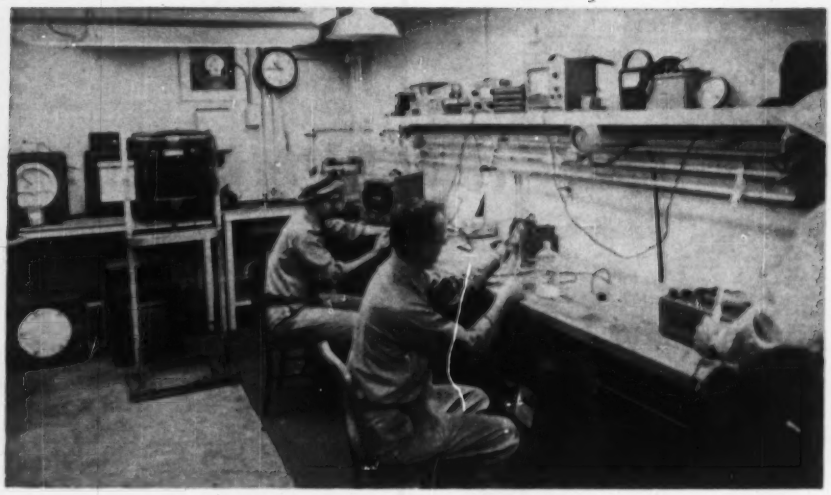
The stock room should be as complete as possible without the danger of having items sitting on the shelves over too long a period of time. Experience is the best criterion for the decision to stock parts. This decision must be based on the cost of the article, delivery time, unit down time, and alternate repair methods in the event of failure, since it is impossible to have perfect coverage. Most instrument manufacturers furnish a recommended spare parts list for each of their instruments, which can be an aid in setting up spare parts for stock.

Procedures

There are many valuable aids that enable an instrument department to perform its job of maintaining and servicing instruments more efficiently. These include

(1) *Weekly Work Schedule.*

(2) *Daily Job Time Slip*—the first copy is sent to



ONE AREA is devoted to the servicing of electronic instruments.

TABLE 1—MAJOR SHOP TEST EQUIPMENT

Equipment	Ranges	Use
6—Model 980 Weston Multimeters	0-400 AC or DC volts 0-800 DC milliamps 0-10 megohm resistances	Trouble shooting of amplifiers and other electronic equipment.
2—No. 8657 L&N Portable Potentiometer Indicators. Acc. ±.3%	0-16 MV 16-64 MV	Checking thermocouples and millivolt recorders.
1—No. 8657 L&N Portable Potentiometer Indicator. Acc. ±.3%	0-64 MV 64-128 MV	Checking bus bar shunts, and high millivolt recorders.
1—L&N No. 7656 Portable Double Range Millivolt Indicator	0-1.11 volt	Checking pH recorders.
1—L&N No. 8662 Potentiometer. Acc. ±.062% (.00062)	0-80.5 MV 1.0166-1.0195 V	Test Standard for portable potentiometer. Checking std. cells.
1—L&N Type S Test Set No. 5300	0-9.999 megohms	Checking resistances to an accuracy of 4 places, .0001 to 9999 ohms. Recalibrating or changing range of Wheatstone bridge type instruments.
2—Commercial Tube Checkers		Checking amplifying and other electronic type tubes.
1—WO-56-4 Oscilloscope	.03 to 30 AC & DC Horiz. & Vert. gains 3-30 KC sweep	Checking electronic circuits.
1—Model 28RS15D Mallory Recto Power Supply	0-16 VDC 0-32 VDC	DC power supply.
1—RCA Audio Signal Generator Model WA44A	11-110 CPS 110-1110 CPS 1.1-11 KC 11-100 KC	Checking electronic equipment.
1—Foxboro Model 9600 Dynalog Calibrator	0-10 ACMV 10-20 ACMV 20-30 ACMV	Checking Foxboro Dynalogs, which are capacity bridge instruments.

production records for use as a daily time slip. From this our maintenance labor costs are tabulated. The second copy is sent to the Instrument Supervisor for his records. The last copy is for the mechanic. He can tell at a glance the work he is to perform and the proper charges for those jobs. He must also produce this card at the storeroom when buying material.

(3) *Requisition on Purchasing Department*—This form is used for ordering all material from outside of the plant.

(4) *Cooperation* with Engineering Department, Works Laboratory, and Technical Department. From the Engineering Department we get blueprints, diagrams, and information for installing new equipment. The Instrument Engineer, in cooperation with Instrument maintenance supervision, specifies and orders new instruments and related equipment for all new jobs above a certain magnitude. The Works Laboratory provides valuable assistance by making chemical analyses that are pertinent to the Instrument Department. The Technical Department furnishes valuable aid in the specification of new instruments by specifying the exact functions that the instruments are to perform, and by analyzing process troubles where instruments appear to malfunction.

Proper catalogs, instruction books, wiring diagrams, installation prints, and equipment drawings are a must in the operation of an instrument department. All of these articles can be obtained, usually cost-free, from the instrument manufacturer. Maintenance record cards should be kept on all major instruments. These cards should provide means of obtaining complete specifications for each instrument, such as serial number, type of material, size, and any other information necessary to reordering the item or obtaining parts for it. This card should also contain the location, application and installation date of the instrument. These cards prove invaluable in many ways—in reordering spare parts, in answering questions pertinent to the instrument, in making instrument and work load surveys, in making maintenance cost records, and in

initiating and maintaining preventive maintenance schedules.

Good instrument maintenance requires a much greater need for technical and clerical services than other types of maintenance.

Electron Tubes

The tubes purchased from most radio and TV supply houses are neither selected nor aged. It has been proved that a tube which has given 100 hours of operation has about 80% better chance of giving another 100 hours of operation than a new tube.

The best way to age and select tubes is to substitute the new tubes into a circuit which is known to be in good operating condition and leave this tube in operation for a period of time. This tube then can be put in stock for replacement of a tube which has failed in different or identical circuits.

Most manufacturers make available selected and aged tubes for their equipment where tube characteristics are critical.

Training

We offer at Westvaco an International Correspondence School course tailored especially to our needs. The Instrument Department is divided into two sections. Each section studies two hours each week in one-hour sessions. One day is left open for make-up classes for absenteeism due to vacation, sickness, etc. The course consists of the following subjects and is conducted and administered on plant premises: Elements of Arithmetic, Fractions, Decimals, Weights & Measures, Ratio & Proportion, Powers & Roots, Geometric Measurements, Formulas, Hydrostatics, Pneumatics, Heat, Electricity (3 parts), Electron Tubes in Industry, Industrial Instruments and Control Mechanisms (9 parts), Industrial Instrument Control (3 parts).

We have almost 100% participation in this program. It is our intention to supplement this course with actual shop training for new mechanics on all types of instruments and for all mechanics on new types.

It should be mentioned that all major instrument manufacturers have excellent training classes for their own instruments, which usually run from one to three weeks. These classes may be attended by an instrument user at no cost except for traveling and living expenses.

TABLE 2—SMALL HAND TOOLS

A minimum of small hand tools would include:

2—10" Ridgid Pipe Wrenches
1—6" Screw Driver
1—L&N Tool Kit
1—Foxboro Tool Kit
1—8" Lineman's Pliers
1—PK2S Pin Punch Set
1—PK8S Pin Punch Set
1—Flashlight
1—Leather Tool Pouch
1—8" Crescent Wrench

Note: Mention of company name is not endorsement; other firms offer similar apparatus.

TABLE 3—PNEUMATIC AND MECHANICAL EQUIPMENT

Equipment	Ranges	Use
1—6" Ashcroft Laboratory Test Gauge, Cat. No. 1082AV	0-30" Hg Vac.	Calibrating vacuum gauges.
1—6" Ashcroft Laboratory Test Gauge, Cat. No. 1082A	0-30 PSI	Calibrating pressure gauges.
1—6" Ashcroft Laboratory Test Gauge, Cat. No. 1082A	0-200 PSI	Calibrating pressure gauges.
1—0-30" Meriam Clean Out Manometer	0-30" water 0-30" Hg	Checking transmitters & low pressure gauges.
1—0-100" Model M-100 WM Dual-tube well type Meriam manometer mounted on 3-4" casters for portability.	0-100" water	Calibrating flow meters and transmitters.
1—Model 40-30 Moore Regulator.	0-30 PSIG	Checking pneumatic instruments.
1—Model 40-200 Moore Regulator.	0-200 PSIG	Checking pneumatic instruments.
1—60 MM Fischer & Porter Test Rotameter	0-20 GPM water	Calibrating high flow rotameters.
1—60 MM Fischer & Porter Test Rotameter	0-3 GPM 0-10 SCFM	Calibrating low flow rotameters.
1—Constant Temp. Bath, Westvaco design	0-300°F 0-500°F	Calibrating temp. instruments.
1—25 lb No. 100 Bethlehem Mercury Oxifier & Gold Adhesion Filter		Cleaning mercury.
1—Black & Decker 8" Heavy Duty Bench Grinder with Cat. #18061 Aluminum Oxide Grinding Wheels		Grinding parts.
1—Black & Decker 8" Heavy Duty Bench Buffer with Cat. #21405 Wire Wheel Brushes		Buffing & Cleaning parts.
6—No. 204R Read Mfg. Co. Vises		
2—24" Ridgid Pipe Wrenches		
1—36" Ridgid Pipe Wrench		
1—No. 312 Combination Greenfield Tap & Die Set	1/4-1"	Threading bolts, & tapping holes.
1—No. AA4 Combination Greenfield Tap & Die Set	#2 to 1/4"	Threading screws & tapping holes.

COMPUTER STORAGE TECHNIQUES

First in a series of articles describing computing storage technology, this installment introduces the general nature and types of storage and its measurement, as well as its functional relation to the computer. Subsequent articles will consider storage techniques now used in digital computers.

G. A. OLIVER
Burroughs Corporation
Research Center

STORAGE, which is preferred to the term "memory," is the property of a device that permits it to introduce time displacement into the transfer of information. A storage device can accept a quantity of information at some instant and deliver a replica of that information at a later instant.

Storage performs the same function as a scratch pad used by a human when he computes a numerical quantity. Storage also is used to retain the sequence of instructions that the computer will perform. A third use of storage is to alter information transfer rates; for example, information coming from some slow-speed input device would be stored and would later be delivered at a higher speed to the computing system. Storage employed in this fashion is termed "buffer storage."

Fig. 1 depicts an idealized computing system. Note first that almost every major division of the machine contains some type of storage. Further, use of storage elements is not confined to the limits of the computer frame and cabinet. This leads to a convenient, broad division of storage as being *INTERNAL* if it is interior to the computer, and *EXTERNAL* otherwise.

The computer's *primary storage* unit constitutes the major portion of internal storage. The main storage is characterized by a medium-to-large capacity and low access-times relative to the operating cycle of the computer. As the primary storage holds both data and instructions, communication with the "arithmetic and control sections" must be provided. Magnetic cores, drums and discs have found wide acceptance in this application.

The cost of large, low-access-time memories is comparatively high. For this reason, as indicated in Fig. 1, the main storage can consist of two or more storage units in cascade. A small, low-access-time storage (e.g., magnetic core) is provided to permit fast computer operations. A larger storage with longer access (e.g., magnetic drum) is then provided to load the fast memory at relatively infrequent intervals. The result of this arrangement is a storage unit of about the speed of the small

TABLE I: SUMMARY OF STORAGE SYSTEM TECHNIQUES AND

	Punched Cards	Punched Paper Tape	Magnetic Tape	Magnetic Drums	Electro-Static	Magneto-Strictive Delay
Type	Static	Static	Static	Dynamic	Static	Dynamic
Access Mode	Sequential	Sequential	Sequential (Random)	Combinational	Random	Combinational
Access Time	0.08 sec. per card	0.01 sec.	0.01 sec. (Seq.) 1-2 min. (Random)	5-20 msec.	10 μsec.	0.5-2 ms.
*Capacity	—	—	$6x10^6$-$30x10^6$ bits per reel	$2x10^3$-$1x10^6$ bits	$5x10^3$-$5x10^4$ bits	$5x10^3$-$5x10^4$ bits
Readout	Non-Destructive	Non-Destructive	Non-Destructive	Non-Destructive	Destructive	Non-Destructive
Volatile	No	No	No	No	Yes	Yes
Erasable	No	No	Yes	Yes	Yes	Yes
Cost	\$0.000002 per bit ($\$2x10^{-6}$)	\$0.00002 per bit ($\$2x10^{-5}$)	\$0.000002 per bit ($\$2x10^{-6}$)	\$0.02 per bit ($\$2x10^{-2}$)	\$1-\$2 per bit	\$0.50-\$1.50 per bit

*For Internal Storage Only

Terminology

The two fundamental measures of storage are capacity and access time.

CAPACITY: The upper limit on the amount of information a storage unit can retain. Capacity is expressed in bits (binary digits) or, alternately, words or characters when the number of bits per word or character is known.

ACCESS TIME: The interval between interrogation of the storage unit and receipt of the specified information.

VOLATILITY: Ability to hold the information when power is lost. Some storage media, such as electrostatic delay-lines, lose information when power is lost.

ERASABILITY: Ability to be reused. Storage media that permit reuse by erasing presently stored information include magnetic tape, magnetic drums, etc. Non-eraseable storage is punched paper tape, punched cards, etc.

DESTRUCTIVE READOUT: Ability to hold the information after interrogation. Interrogation of stored information causes some storage media (electrostatic, magnetic core) to return to a neutral state and the information to be lost.

COST: Frequently expressed as dollars/bit.

PHYSICAL PROPERTIES: Size, power, cooling requirements, etc.

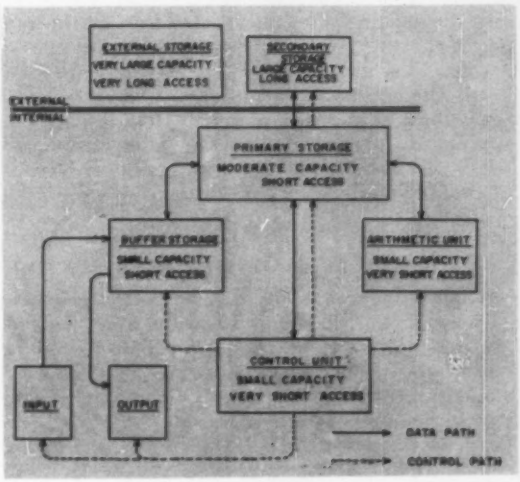


FIG. 1. EXTERNAL STORAGE features large capacity and long access time; internal storage features smaller capacity and access time.

high-speed store, but with the capacity of a much larger store.

Storage requirements in the "arithmetic and control units" are small in comparison to the main storage—usually not more than three to five words. To avoid slowing the machine operation, however, very short access time is desirable. For these reasons and others (e.g., depending on information transfer required for a particular machine operation), the storage elements in the arithmetic and control sections are organized into several single-word storage units. These single-word stores are called *registers*. The description "zero access" has been applied to registers because of their very low access time. Registers usually comprise flip-flops or special magnetic-core circuits, although the same effect can be obtained by organizing data properly on a magnetic drum.

The function of *buffer storage*, as mentioned, is to match the high speeds of the computer with the lower speeds of the peripheral input/output units. As large capacity usually is not required, flip-flops or small magnetic core-store can be employed. Buffers that have a capacity in excess of one word generally are arranged to deliver information precisely in the order received. (In some larger computing systems, however, the programmer is given control of the order in which data will be taken from the buffer.)

The *secondary (auxiliary) storage* is in the awkward position of being external to the computer but of being controlled by the computer. Secondary storage provides extremely large-capacity, long-access, low-cost storage required for files, program

THEIR CHARACTERISTICS

Magnetic Core	Vacuum Tube	Magnetic Thin Film	Random Access Magnetic (Discs)
Static	Static	Static	Dynamic
Random	Random	Random	Combinational
2-10 μsec.	1 μsec.	0.1-0.5 μsec.	0.5-1.0 sec.
5×10^{4}-5×10^{5} bits	50-100 bits	5×10^{4}-5×10^{5} bits	40×10^{6} bits
Destructive	Non-Destructive	Destructive	Non-Destructive
No	Yes	No	No
Yes	Yes	Yes	Yes
\$0.50-\$4.00 per bit	\$10/bit	Not Yet Established	\$0.002 per bit ($\$2\times10^{-3}$)

libraries, and the like. Magnetic tape usually is employed; magnetic discs are used in some newer equipment.

We come, finally, to *external storage*. This type of storage is neither connected to or controlled directly by the computer. Media used include punched card, paper tape, magnetic tape, photographic film, printed pages, etc. Access is long because the media must usually be selected from some type of file and manually inserted into an appropriate reading device. Only the lowest cost media are suitable for this class of storage because of the very large capacity required.

Primary Storage

A block diagram of a typical *primary storage unit* is shown in Fig. 2. The individual storage elements are organized into a large, interconnected set of one-word registers (storage locations). This set of storage elements is the heart of the unit; the remaining equipment serves only to gain access to a given location and to operate on the information contained in that location.

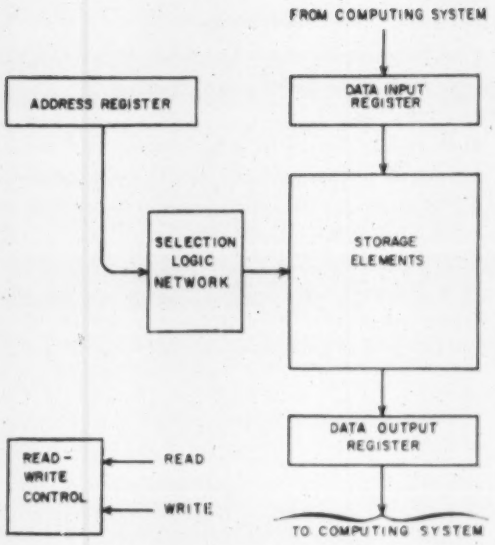


FIG. 2. PRIMARY storage units.

Static or Dynamic

Although many physical phenomena have found application as storage elements and a large number of different hardware arrangements have developed, all storage phenomena can be classed as being either static or dynamic. *Static* storage is that from which the stored information is continuously available and is fixed in space; the flip-flop and the magnetic core storage are examples of this type. Information held in *dynamic storage*, on the other hand, is moving in time and is not continuously available. The magnetostrictive delay line and the magnetic drum are examples of this class of storage. The type of storage used controls the nature of the entire system, as will be seen.

Access to a given word of data is achieved by inserting the address of the selected location into the address register (Fig. 2). Signals from the address register activate the selection network which, in turn, connects the specified group of storage elements to the input and output register.

Storage Access

There are three principal types of access—random, sequential, and combinational. Random access implies that the access time for a word in storage is independent of the location of a previously addressed word.

Some storage techniques (e.g., magnetic core) provide random addressing capabilities, as shown in the second line in Table 1.

The term *sequential access* means that the desired data are located by searching through all locations, beginning with the one presently accessible, until the desired location is found. Access time thus depends on the location of the selected word in the storage. Magnetic tape is a good example of a technique having this type of access.

Combinational access is intermediate to sequential and random and is an access mode typical of dynamic storage techniques. Consider a magnetic drum having a large number of tracks in parallel, each of which contains several words stored *serially*. Access to a particular word requires specification of a track and an interval in time. These are, respectively, random and sequential access modes. Hence it is called combinational.

Note that if the computing system is arranged so that it never calls for information from the storage at a rate in excess of that established by the longest possible combinational access time, access is effectively random. This is why the term "random-access" is applied to certain large-capacity magnetic-disc storage units.

Once access to a selected location is obtained, information can be written into or read out of that location. Again, there are three possible modes of operation—(1) parallel, in which all of the bits of the entire word are operated upon simultaneously; (2) serial, in which the word is handled by bits singly and successively; and, (3) combinational, in which, for example, a word can be treated serially by digit and parallel by bits comprising the digit.

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E. M. Grabbe and D. E. Wooldridge, *Handbook of Automation Computation and Control*, Vol. 2, John Wiley and Sons: New York, N. Y., 1959.

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J. P. Eckert, Jr., "A Survey of Digital Computer Memory Systems," *Proc. I.R.E.* 41 (10) 1391-1406 (1953).

NEW

E-W Time Code Generator

Model 6190

...Makes time with Atomic Accuracy

Solid State EW Timing Code Generator Uses Atomchron Input

Epsco-West's new Model 6190 Time Code Generator is accurate, flexible, and reliable. In conformance with recommendations of the Interrange Instrument Group (IRIG), the Model 6190 generates a 36 bit 100 pps code, a 28 bit 2 pps code and a 20 bit 1 ppm code. Other outputs are available to drive digital printers, digital tape recorders, strip-chart recorders, oscillograph galvanometers, synchronizing signals and mixed tones of precision frequencies.

The EW Model 6190 is one of a complete line of solid state, modular time code equipment which includes time code generators, time code translators, timing terminals, and universal tape search equipment.

Complete technical information on the Model 6190 Time Code Generator is ready now. Call your nearby knowledgeable Epsco-West engineering representative or address Dept. 54.

Advanced Circuitry Stems From Transistor Know-How

In the Model 6190, all pulse widths and timing are directly derived from the digital dividers and time accumulator by diode matrices. No one-shot circuits are used. Information is not transferred from one register to another. No "stub" counter chains are used. These design features provide absolute synchronism and minimum distortion. Modulation occurs precisely at the true positive going zero-axis point on the carrier.

Epsco-West
First in Data Control
A Division of EPSCO Inc., Cambridge, Mass.

240 E. PALAIS ROAD • ANAHEIM, CALIFORNIA

KEY SPECIFICATIONS

Input Signal
100 kc, 1-volt RMS, to impedance of 10,000 ohms. An internal frequency standard may be supplied as optional equipment.

Outputs
1. Logic Output, 36-bit parallel BCD (—12v for binary "zero", 0-volts for binary "one").
2. 20-bit, 1 ppm on 100 cps carrier, 1 hour time frame.
3. 28-bit, 2 pps on 100 cps carrier, 1 minute time frame.
4. 36-bit, 100 pps on 1000 cps carrier, 1 second time frame.
5. Three outputs of the 100 pps, 2 pps and 1 ppm modulation pulses at 2 milliampere max. for driving galvanometers.
6. Relay closure at 1 ppm, 28-bit, 2 pps code, closure for pulse durations.
7. 1 pps at 1-volt, synch pulse, accessible front and rear.
8. 1 pps relay closure of 200 ms.
9. Mixed tones output; 100kc, 50kc, 25kc, 12.5kc, 6.25kc, 3.125kc sine waves.

Elapsed-Time Range
399 days 23 hr. 59 min. 59 sec.

Accuracy
Dependent only on reference oscillator.

Size
19" wide by 10½" high x 18" deep.

CIRCLE 55 ON READER-SERVICE CARD

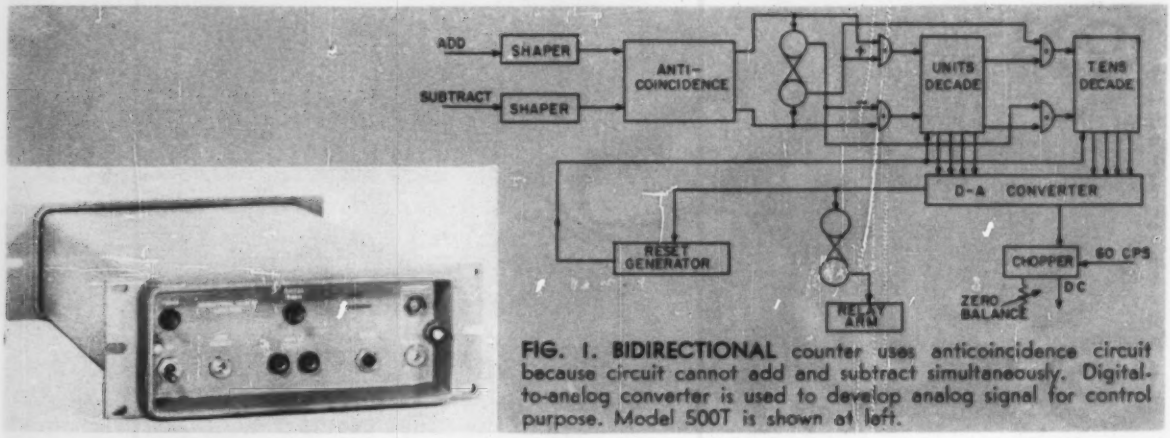

FIG. 1. BIDIRECTIONAL counter uses anticoincidence circuit because circuit cannot add and subtract simultaneously. Digital-to-analog converter is used to develop analog signal for control purpose. Model 500T is shown at left.

BIDIRECTIONAL COUNTING

Bidirectional counting requires anticoincidence techniques to separate add and subtract functions. The techniques have important digital control implications.

ROSS E. HUPP
Erie-Pacific Division
Erie Resistor Corp.

BIDIRECTIONAL or add/subtract counters are finding general use in the field of digital automation. Fig. 1 is a block diagram of a bidirectional counter. Add and subtract inputs are fed through an anti-coincidence circuit to a directional-control flip-flop, which determines whether pulses will be added to, or subtracted from, the existing count.

Anticoincidence Circuit

The anticoincidence circuit is the key to bidirectional counting. As the counter cannot add and subtract simultaneously, the pulses must arrive at the counter sequentially. Two types of anti-coincidence circuits can be used to drive the add and subtract inputs of the counter.

The first uses two flip-flops, a free-running symmetrical multivibrator (clock), and two AND gates (Fig. 2). The set input of one flip-flop is driven with a suitably-shaped pulse arriving from the add source, and the other flip-flop input is driven from a similar pulse from the subtract source. Clock pulses generated by the symmetrical multivibrator alternately interrogate each AND gate, which is in turn connected to the reset input of its respective flip flop.

Considering the Add flip-flop at the left, an ADD pulse flips the bistable circuit to a 1 state, enabling the associated AND gate. A subsequent pulse from the clock interrogates the AND gate, flipping the flip-flop back to the zero state, at the same time producing an output pulse which drives the counter in a forward direction. Obviously, if the flip flop had not been changed to the 1 state with an ADD pulse there would be no output upon interrogation.

The action of the subtract flip-flop is identical to that of the add flip-flop. To prevent loss of add/subtract pulses at high input rates, the interrogation frequency (clock pulse rate) should be several times higher than the input rate. One of the disadvantages of this type of anticoincidence circuit is the relatively high clock frequency required.

A more sophisticated type of anticoincidence circuit (Fig. 3) uses five one-shot (delay) multivibrators and two AND gates to sense a coincidence—automatically delaying one of the pulses sufficiently to fall within the resolving time of the

counter used. The two one-shots on the left generate rectangular waveforms of a pulse width chosen to afford maximum separation between add and subtract pulses in the region of coincidence. For example, an output from the first AND gate triggers one-shot multivibrator No. 5 if there is a time overlap of the two pulses. The result is an added fixed delay of the subtract pulse. If there is no overlap of the add and subtract pulses from one-shots 1 and 2, then the pulses will be separated (by the minimum time of the pulse width). The trailing edges of the rectangular pulses drive one-shots 3 and 4.

When an overlap does occur the add pulse in the upper channel drives the add counter input, but the normal subtract pulse is inhibited, and one-shot 5 introduces an additional delay, using the trailing edge of the inhibit gate waveform to drive the subtract input of the counter. The additional delay of one-shot No. 5 assures sufficient time separation between add and subtract pulses even at the worst condition of coincidence. If high-frequency transistors are used, the delay times can be kept to a minimum and high repetition rates will be tolerated. An upper limit of 100 kc is obtained using relatively inexpensive PNP transistors.

Digital-to-analog conversion is often desired for control purposes. It is obtained in each decade through a resistance-summing network which weights the voltage output of each binary in the decade. The output of each decade is in turn summed for the final d-c output of the counter.

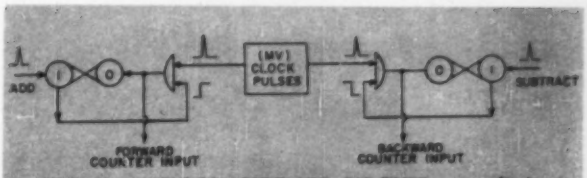

FIG. 2. ANTICOINCIDENCE CIRCUIT using clock pulses to enable "add" circuit and "subtract" circuit alternately.

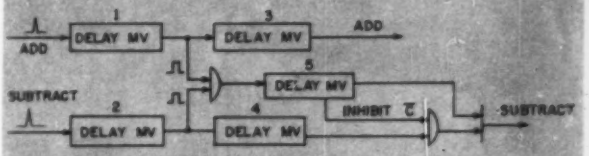

FIG. 3. THIS ANTICOINCIDENCE circuit uses five one-shot delay multivibrators to impose added delay on the subtract signal if the add and subtract signals appear simultaneously.

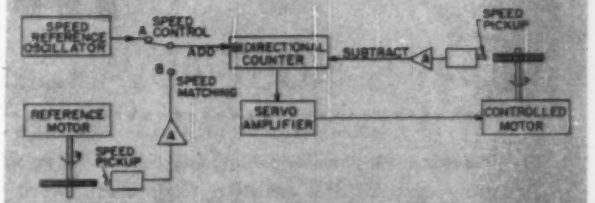

FIG. 4. CONTROL OF MOTOR speed by a bidirectional counter.

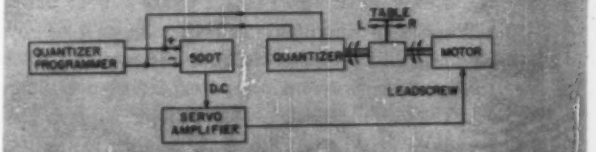

FIG. 5. POSITION CONTROL by a bidirectional counter.

Applications

One digital control application of the bidirectional counter is absolute control of motor speed. In Fig. 4, pulses generated by a reference motor are fed to the add input of the counter. The controlled motor produces pulses which drive the subtract input of the counter. If the motors are running at precisely the same speed, pulses are generated at the same rate and the bidirectional counter output should not vary more than ± 1 count. (The random 1-count error is due to the relative phase between the pulses produced at either input.) However, over an extended period the average count (and analog voltage) will be zero. The d-c analog voltage drives the input of a servo amplifier, which in turn drives the controlled motor. The control point is established by adjusting the drive voltage of the motor to an optimum value for the speed range desired.

If the speed of the reference motor increases, pulses are generated at a faster rate, increasing the count and d-c output voltage. The servo amplifier increases its drive to the controlled motor, bringing about a speed correction. Tight control of motor speed has been obtained over a speed range exceeding 30 to 1 with no adjustment of the d-c reference voltage of the controlled motor.

For programmed speed control a variable-frequency oscillator can be used in place of the reference motor, and a frequency equivalent to the desired speed is fed into the ADD input of the bidirectional counter.

Another use of the bidirectional counter is flow rate control and fuel blending for the petroleum industry.

Still another application of the bidirectional counter is that of position control. The block diagram of Fig. 5 shows the typical arrangement of quantizer, bidirectional counter, motor, and servo amplifier. One quantizer serves as the reference, and its forward and backward output pulse lines are applied to the anticoincidence forward-backward input of the bidirectional counter. The other quantizer located at the shaft to be positioned is connected in opposition. If the reference quantizer is replaced with a pulse generator, position programming is possible. Command pulses can be generated through a punched paper tape, a magnetic tape or punched card means, or even through a series of selector switches. The bidirectional counter or accumulator provides a means of high-speed positioning, whether it be angular or linear, in any direction.

TIMING INSTRUMENTATION

With the Bendix G-20 Computer You Can

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TODAY'S MOST ADVANCED COMPUTING "PACKAGE"

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• The G-20's simplified programming enables your present personnel to take advantage of the powerful problem-solving abilities of the computer, regardless of their previous computer experience. Such a programming system is ALCOM—an algebraic problem-solver based on the international mathematical language of ALGOL. Compatible with the ALGO programming system for the Bendix G-15, ALCOM permits your technical staff to transmit problems to the floating point circuitry of the G-20 in universal mathematical language.

• ALCOM is complemented by a library of sorting, file maintenance and other routines for specific tasks. The refined indexing and decision-making capabilities of a powerful command vocabulary have been instrumental in making these simplified techniques possible. They are unmatched for ease of use and efficiency. • Not overlooking the G-20 proper, we have recently increased computing speeds by 40% ... to the rate of 83,000 additions per second (average, floating point, one-word precision). Magnetic tape speed is now 240,000 digits per second ... and printing speed can be up to 1500 lines per minute. These new characteristics, combined with the G-20's efficient "organization chart" system design and perfected programming ease, provide an unmatched return on your computing dollar. Prove this fact to your own satisfaction.

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Radioactivity-Controlled Time-Delay Circuits

UNIT AT LEFT is a model of the basic nuclear timer. Unit at right is a working model of a nuclear-timer oscillator coupled to drive a mechanical totalizing device to provide a selectable delay time from hours to years.

C. L. SMITH, P. J. KISATSKY, Picatinny Arsenal

Electronic time delay devices have been developed utilizing radioactivity-stabilized and controlled components and featuring high accuracy, ruggedness, long shelf life, self-power and repeatabilities over adverse environmental conditions of better than 0.1%. Developments in power sources, having long shelf lives, have made practical this development.

TIME-DELAY DEVICES which are reliable, rugged, and long-lived are required in satellites and weapons. This requirement led to the development of the basic circuit in Fig. 1, capable of operating with power in the microwatt range. Other groups have experimented with similar circuits, but have reported only modest accuracies and repeatabilities. Nuclear batteries utilizing krypton 85 as the active element perform satisfactorily and can be made in volumes of less than one-eighth cubic inch. Tritium can also be used to produce practical power sources, although manufacturers have experienced mechanical design problems with this cell. The solid electrolyte type of battery is presently available in small quantities.

Basic Timing Circuit

The basic circuit of Fig. 1 consists of a power supply (a regulating circuit with nuclear battery or solid ion batteries), an ion chamber, timing capacitor and gas diode. This circuit owes its stability to the radioactive control of three of the major components—the power supply, the ion chamber, and the gas diode.

If a nuclear battery is used as the power source, the power is derived from the released energy of an active isotope. In the ion chamber, a radioisotope ionizes a definite fraction of the contained gas, and if the tube is operated in its saturation region there results a constant current.

The breakdown voltage of the gas diode is also stabilized by the presence of radioactive material. The active material is used to maintain a pre-firing ionization of the gas—this lowers the firing voltage and contributes to the reduction of randomness associated with the breakdown of the tube. Hence, radioactivity plays a significant role in this system.

As the ion chamber produces a *constant current,* the expression for the time t for the capacitor to charge to a potential V is simply

$$t = CV/I$$

where t = delay time, C = capacitance, V = striking voltage of the diode, I = ion-chamber current.

Completely packaged and tested timing units for various environmental extremes have been constructed and tested having delay times ranging from seconds to twenty hours. These units maintain a timing reproducibility of within 0.5%, and maintain this tolerance over temperatures from −65°F to + 165°F in the presence of shock and radiation.

This reproducibility has been achieved mainly by special techniques in the selection and stabilization of the components, and investigation and application of potting and packaging methods. The circuit of Fig. 1 can be packaged in 4 cubic inches, and weighs approximately 100 grams.

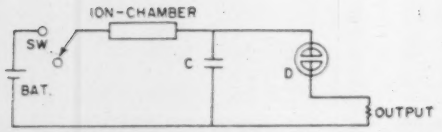


FIG. 1. BASIC radioactivity-controlled time-delay circuit.

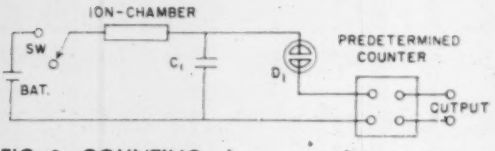


FIG. 2. COUNTING of successive firings averages out the random-firing error.

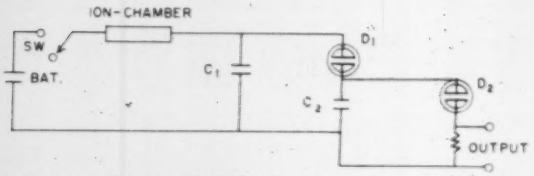


FIG. 3. EACH FIRING of D_1 places a charge on C_2. After a predetermined number of D_1 firings, D_2 fires.

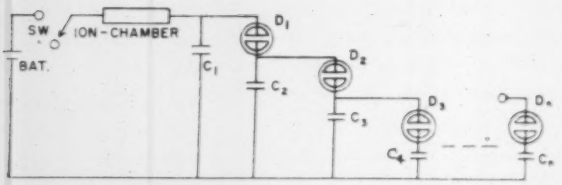


FIG. 4. METHOD for making final tube fire at nth pulse.

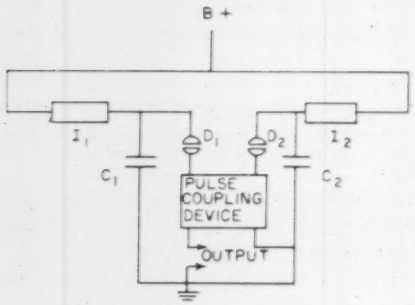


FIG. 5. TECHNIQUE for counting and averaging n pulses.

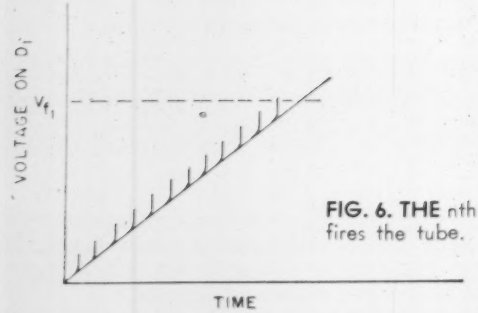


FIG. 6. THE nth pulse fires the tube.

Advanced Techniques

The limitation of these circuits to a timing reproducibility of 0.5% can be attributed mainly to the gas diode. Other variables (voltage coefficient of capacitance, temperature coefficient of capacitance, insulation resistance, capacitor polarization effects, etc.) can be made insignificant by testing and selection of components. However, even selected types of gas diodes exhibit a random firing repeatability and also a random extinction-voltage repeatability. As this random effect appears to be the basic limitation of these type circuits, methods were considered to average out this randomness.

If a time delay could depend on many firings of a diode rather than a single ignition, the reproducibility of the circuit could be improved. In Fig. 2 the circuit could fire a predetermined number of times to produce a time delay equal to t_a. That is, $t_a = n\ t_a$.

The average time for a pulse would be

$$t_a = (t_1 + t_2 + t_3 \ldots\ldots\ldots t_n)/n$$

Then

$$t_a = nt_a$$

This is an averaging process. If s_t is the standard deviation of a number of single-shot timings, then in a multiple-shot timing the standard deviation s_t equals $s_t/\sqrt{n}$, an improvement factor of $\sqrt{n}$. The same would be true for the range

$$r_t = r_t/\sqrt{n}$$

This indicates the maximum possible improvement attainable in utilizing the totalizing technique.

Totalizing

By utilizing the basic timer circuit and by allowing the timer to continuously recycle, a low-frequency oscillator or clock-pulse generator can be designed. In order to attain frequency stability in such an oscillator, it is not only necessary that the gas-tube breakdown voltage be stable but that the cut-off voltage of the tube also remain constant.

Cold-cathode trigger tubes can reproduce their firing voltage and extinction voltage to within ±1% from −65°F to 165°F. Using these tubes, time-base generators yielding one pulse every ten seconds have been constructed. They have been made completely self-powered by solid electrolyte-type batteries in a volume for the complete package of about 6 cubic inches, and with a frequency stability of ±1%. When the output pulses are counted, the pulse generator can be used to provide long time delays with the inherent statistical improvement in accuracy, as discussed previously.

A laboratory-type preset counter (Fig. 2) was used; timings were obtained by counting a predetermined number of diode firings. When an ordinary neon-filled gas tube was used as the triggering device in a 10-second basic circuit, the repeatability was 10 seconds ±2%. The 2% spread of times obtained was due primarily to the 2% repeatability in gas-tube firing voltage.

When the preset counter was set to count off five of these time intervals (associated with five consecutive and random gas-tube breakdowns) the repeatability of the timer improved to ± 1.1%. By setting the present counter to totalize 10 individual and random pulses, the repeatability improved further to ±0.43%. Note that the averaging tendency of the totalizing process contributes significantly to the improvement of time repeatability, as expected.

By utilizing improved gas diodes, laboratory model timers have been fabricated complete with contained power sources and totalizing circuits that yield time repeatability within ±0.1%. Thus averaging technique led to improvement in timer repeatability by a factor of ten. To investigate whether accuracy can be improved continually by extension of the total number of counts in the averaging system, the counting of larger number of pulses was attempted. It was observed that as the repeatability continues beyond the 0.1% band, the inherent limitation of other components in the circuit is reached. For example, the temperature coefficient of the timing capacitor, as well as the trigger-tube voltage repeatability begins to contribute to the timer error. At this time, a repeatabil.ty of ±0.1% under a wide range of environmental conditions appears to be a practical limit.

Circuit Design

One means of totalizing pulses from an ion-chamber capacitor-diode oscillator is shown in Fig. 3. The firing of D_1 places a charge on C_2 so that when a predetermined number of charges have been accumulated, D_2 fires and produces an output pulse. To obtain the optimum accuracy by always firing D_2 on the predetermined nth pulse, it is necessary that the magnitude of the pulses as they appear on C_2 be such that they encompass the firing voltage tolerances of D_2. This limits the number of firings of D_1 to be totalized by the C_2-D_2 accumulator.

In order to totalize any desired number of pulses, the circuit of Fig. 4 was considered, where the time of initial firing of the first diode D_1 is

$$t_0 = C_1V_1/I_1 \qquad (1)$$

the time for any successive firing of D_1

$$t_1 = C_1(V_1 - V_e)/I_1 \qquad (2)$$

where V_1 = firing voltage of D_1, V_e = extinguishing voltage of D_1. Let $\Delta V = V_1 - V_e$. Neglecting the slightly longer time of the initial firing of D_1, let Equation 2 be the time for any firing D_1. As the voltage delivered in each pulse of D_1 is a ratio of the capacitors.

$$V_p = \Delta VC_1/(C_1 + C_2) \qquad (3)$$

Thus the number of pulses required to fire D_2 is:

$$N_{D2} = V_2/V_p \qquad (4)$$

The time required to fire D_2:

$$t_2 = (C_1\Delta V/I_1)(V_2/\Delta V) \qquad (5)$$

If the firing voltages and extinction voltage are the same for all diodes, the time required to fire the n^{th} diode is:

$$t_n = C_1\left(\frac{\Delta V}{I}\right)\left(\frac{V_2^{n-1}}{\Delta V^{n-1}}\right)\left(\frac{C_1}{C_1 + C_2}\right)^{-n}$$

This would be true for only a special case—where the predetermined number of pulses would exactly equal the firing voltage of the diode of the succeeding stage. In practice this would be difficult to obtain. It can be seen that at the termination of each staccato of a stage (the number of pulses required to fire the succeeding diode) both diodes would be firing simultaneously. This would mean that if the predetermined number of pulses did not add up to exactly the firing voltage of the succeeding stage, that the charge transferred would be difficult to predict and the circuit design parameters could be determined only by experimental methods.

The total number of pulses required to produce an output from a circuit of n stages also can be determined.

Another method of improving the timing accuracy by counting and averaging exactly n pulses of a basic time interval is shown in Fig. 5. In this circuit, the gas diode D_2 and capacitor C_2 would operate as the clock pulse generator, and the signals would be fed through a coupling network to the diode D_1, which would meanwhile have a ramp voltage impressed on it due to the charging of capacitor C_1.

As the clock pulses are coupled to the diode D_1, the resulting voltage of D_1 would appear as in Fig. 6. A given n^{th} pulse would always overdrive tube D_1 and fire it. It can be seen that tube D_1 acts only as an accumulating device and the timer is independent of the firing voltage error of D_1. However, the random variations of time interval, caused by variations in firing voltage of D_2, are averaged out in the counting process of the n number of pulses.

However, the clock pulse frequency cannot be too high or too low.

The desired input frequency can be computed.

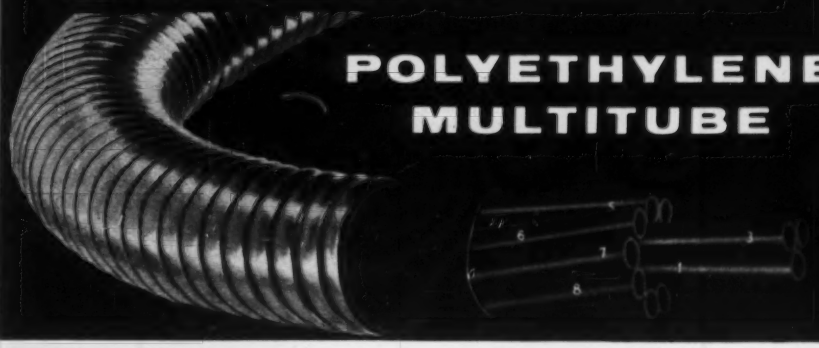
Summary

The techniques described provide totalizing methods that are compatible with the basic timer, in that they can be powered by the same low-current source. Also, other methods have been tried that require additional batteries. These have produce time-delay units with improved reproducibility. Considerable effort has been given to developing special components to provide variable time delays. A variable ion chamber has been investigated and found to be feasible. A 50% variation in the ion-chamber current can be accomplished by incorporating a device to change the gas pressure within the envelope. Also, variable-firing-voltage diodes have been investigated and found to be feasible but would involve a compromise of some of the other parameters.

CRESCENT

POLYETHYLENE MULTITUBE

VALUE



with INDIVIDUALLY NUMBERED TUBES

INDIVIDUALLY NUMBERED TUBES—Numbers in white appear at 2-1/2" intervals throughout the length, thus permitting positive identification of every tube anywhere along the length, as well as at each end.

BLACK POLYETHYLENE TUBES—Pigmented, high molecular weight virgin polyethylene Type P tubes are employed for maximum resistance to environmental stress cracking and aging in sunlight.

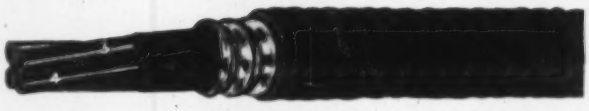
THREE STANDARD TYPES TO MEET YOUR SPECIFIC NEED

CRESCENT POLYETHYLENE MULTITUBE is composed of 2 to 37 individually numbered, black Type P tubes spirally cabled together for greatest flexibility and to eliminate distortion and stress on the tubes when bent to a small radius. The tubing assembly is protected against mechanical injury by a flexible, interlocked, galvanized steel armor, or a polyvinyl chloride (PVC) sheath or a combination of both where it is desired to protect the metallic armor against corrosion.

STANDARD TYPES

TYPE PA—Interlocked metallic armor provides complete mechanical protection to the inherently corrosion resistant tubing.

TYPE PAT—Polyvinyl chloride sheath over the armor adds corrosion protection for the armor. Can be buried in the earth.



TYPE PT—PVC sheath gives limited mechanical protection. For use in troughs, trays or conduit.

CRESCENT POLYETHYLENE PRECISION INSTRUMENT TUBING—TYPE P developed through extensive research, improved manufacturing methods and rigid test standards, will continue to be available in 1/4", 3/8" and 1/2" OD sizes in up to seven bright colors and black for use as single tubing behind panels and in MULTITUBE when specified.

CRESCENT INSULATED WIRE & CABLE CO., INC.

TRENTON, NEW JERSEY

CIRCLE 56 ON READER-SERVICE CARD

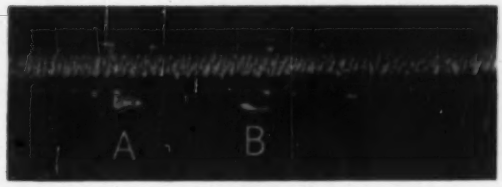


FIG. 1. MICROPHOTOGRAPH of stressed enamelled wire shows damage to insulation.

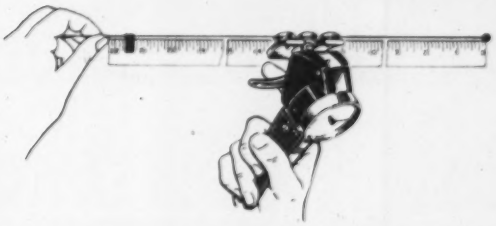


FIG. 2. TENSION test can be made by plotting tension versus elongation as wire is pulled by hand.

Tension in Industry

Tension is a common problem in wire and yarn production, in manufacturing of printing paper or plastic sheet, in winding a coil, in preparing and handling yarn and tape of all types, in manufacturing capacitors, etc.

DR. ERWIN J. SAXL
Tensitron, Inc.

TENSION can cause change in a material due to physical deformation, stress hardening, and narrowing of the material. For example, if tension is excessive, wires will break or yield under stress; if narrowed, they cannot carry safely the same amount of current (the latter can cause local overheating called "hot spots"). Wires not sufficiently tensioned will not fill the cavity of a given stack of laminations or will be loose, causing unbalance to rotating equipment or protrusion in an air gap. Narrowing down of wire or yarn under stress beyond its limit of elastic recovery is a serious condition. When stretched to the point of "flow," plastic (such as a polymer) will change physical structure. A metal stressed beyond the point of elastic recovery will stress-harden. All of these are examples of industrial need for tension control.

When several wires are laid into a cable simultaneously, or strands twisted into a tire cord, all should have the same tension or else some will shrink more than others when tension is released. This important factor for keeping cables straight when unrolled is required by the specifications of the U.S. Signal Corps and other military agencies—and to make automobile tires safer.

In production, we usually must deal with *dynamic* tension, the quick increase and decrease of strain, as in starting a machine, or when the smooth progress of a material is interrupted. Such quickly-changing tension damages a material more than a constant pull; the sudden rise is the equivalent of shock.

Fig. 1, a microphotograph of a fine enamelled copper-wire that has been stressed suddenly beyond its safe limits, shows two types of damage to the insulation.

Between tension extremes there is the comparatively limited range of "safe tensions" within which all filament and sheet-like materials should be handled.

TABLE 1—AWG (AMERICAN WIRE GAUGE) DATA

AWG Size	Dia (inches)	Area (circ. mils)
4	0.2043	41,740
7	0.1443	20,820
10	0.1019	10,380
13	0.0720	5,178
16	0.0508	2,583
19	0.0359	1,288
22	0.0254	642.5
25	0.0179	320.4

Note: The following aid to memory can be used: No. 10 wire has approximately 10,000 circular-mil area; the area doubles (or halves) every three sizes.

TABLE 2—TEST OF AWG 38 WIRE BY TENSION METER

Tension (grams) measured on the Tension Meter	Length of Wire (inches)
0	20
30	20-1/16
35	20-1/8
40	20-1/4
40	20-1/2
40	20-5/8
40	20-3/4
43	21
45	22
45 (break)	22-3/8

FIG. 3. TRIGGER tension-meter. Meter can be mounted on bracket on a coil-winding machine.

FIG. 4. TAPE tension meter is used in production of magnetic tape, capacitor foils, etc.

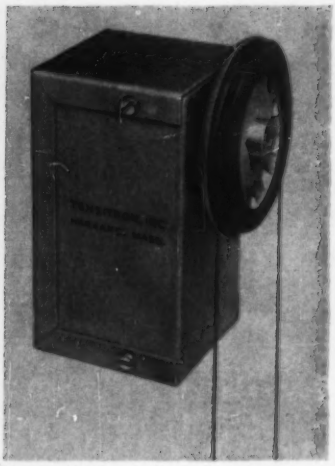


FIG. 5. ELECTRIC tension control has many advantages over friction-type control.

Tension Measurement

Tension can be measured during actual processing operations by a three-roller device (Fig. 3). The two outer rollers furnish the reference position for the wire; the center roller is restrained by a precise, flat beryllium-copper spring. This small deflection is amplified mechanically by a gear train, showing the deflection of the center roller on the dial.

The two outer rollers are retracted when the trigger is depressed. With the rollers thus opened wide for wire insertion, the instrument is positioned so that it runs on the two outer rollers. Releasing the trigger gently, the wire now falls automatically into position between the three rollers. The ball-bearing rollers are recessed into the surface of the guiding shield so that the wire cannot get caught in the rollers—an important detail when dealing with wires travelling as fast as 10,000 ft/min.

A simple empirical test on thin wires can be made with the instrument shown in Fig. 2. The wire is held by a binding post or clamped at one end, as shown in Fig. 2. The other end is pulled by hand while the tension on the wire is read on the Tension Meter. It can be "felt" when the wire exceeds its elastic limit and starts to yield—that is, when more pull on the wire does *not* produce an increase in tension as shown on the tension meter. Elongation of the wire is observed along a graduated measuring tape, and the elongation of the wire can be plotted against the applied load. This provides a simple manner for estimating elastic limit, break point, and safe tension for a wire.

The data are shown in Table 2.

Yielding and permanent set started in the vicinity of 40-gram pull, despite the fact that the final break did not occur until 45-gram tension.

This static test should not be construed as a standard test method; pulling speed and specimen length do influence the ultimate breaking strength. However, this static method is a practical method for estimating the tensional characteristics of a given wire.

As a starting point, accept one quarter of the critical tension (load above which injury takes place) as a safe tension, and engineer set-ups accordingly. If tensions are maintained accurately at all times, higher tensions then can be used; this requires proper tension control.

Tension Control

Existing restraining devices too often use friction, whereby the wire or yarn is let through rubbing surfaces. The surface of these friction "brakes" may range from felt pads and oiled cork (for wires) to metal disks (used in the textile industry). In a fine yarn such as nylon, this can cause broken filaments; in enamelled wire, use of friction can reduce the size of the insulation. In addition, the tension in a friction device is higher until "break away" tension is reached, and thereafter the running tension is lower.

A new concept makes use of a light-weight wheel of minimum inertia that transforms the linear motion of the wire into a rotary motion of the wheel (Fig. 5). This rotary motion then can be controlled by remote electro-magnetic methods for smooth stepless retardation; the non-slip wheel covering has serrations in its groove to increase traction between wire and wheel cover. This electric tension gives non-slip traction of wires smaller than 0.0005", regardless of how fine the insulation is. It permits tensioning of the finest nylons.

Remote control of the tensioning wheel makes it possible to mount the latter a distance from the coil-winding machine or processing means. The many feet of wire between wheel and wound product permits elastic equalizing of varying tensions during production. This is an important detail in winding square potentiometer strips or non-round grids of electron tubes.

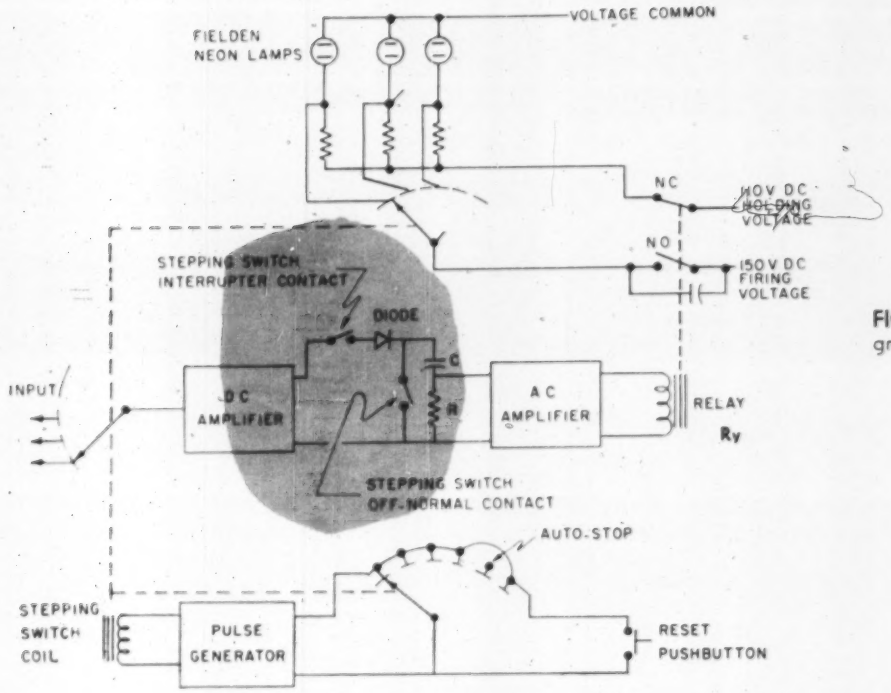


FIG. 1. BLOCK diagram of system.

Hottest-Point Seeker

This memory system indicates the input line that has the highest signal level; it can show highest temperature if system is scanning thermocouples, or the extreme signal of any d-c input scanner.

J. W. ADAMS
E. I. duPont de Nemours & Company
Savannah River Plant

IDENTIFICATION of the highest signal value while scanning many signals can be performed automatically with (Fig. 1):

(1) a scanning system to scan the several d-c signals.

(2) a memory circuit to compare each signal against the largest one received in the scanning cycle.

(3) a neon-lamp panel to identify the point which gave the largest signal during the scan. Neon lamps are convenient as memory devices because, once lit by a voltage pulse, the lamp stays on.

The scanner is a multi-level stepping- switch which performs three functions:

(1) It scans the signals from the several monitored points sequentially, and applies each selected voltage to the input of the comparator circuit.

The information contained in this paper was developed during the course of work under Contract AT (07-2)-1 with the Atomic Energy Commission.

(2) It connects the neon lamps (which identify the measured points) to the comparator circuit output in synchronism with the input circuit selector. Each indicator lamp is thus associated with its signal source.

(3) It automatically stops the scan and resets the circuits at the completion of a cycle.

Automatic shut-off of the scanner is accomplished by having one open point in the pulse generator control circuit so that the scanner will stop at the open point. Operation of the scanner is initiated by closing this circuit with the reset button.

Speed of operation is limited by the pull-in and drop-out characteristics of the relay (Ry) in the output of the comparator circuit. The prototype operated satisfactorily at speeds up to 3 points per second. The electronic circuit is simple (Fig. 2) and contains only four vacuum tubes.

The d-c signals from the monitored points are fed by the scanner to the grid of a cathode-follower

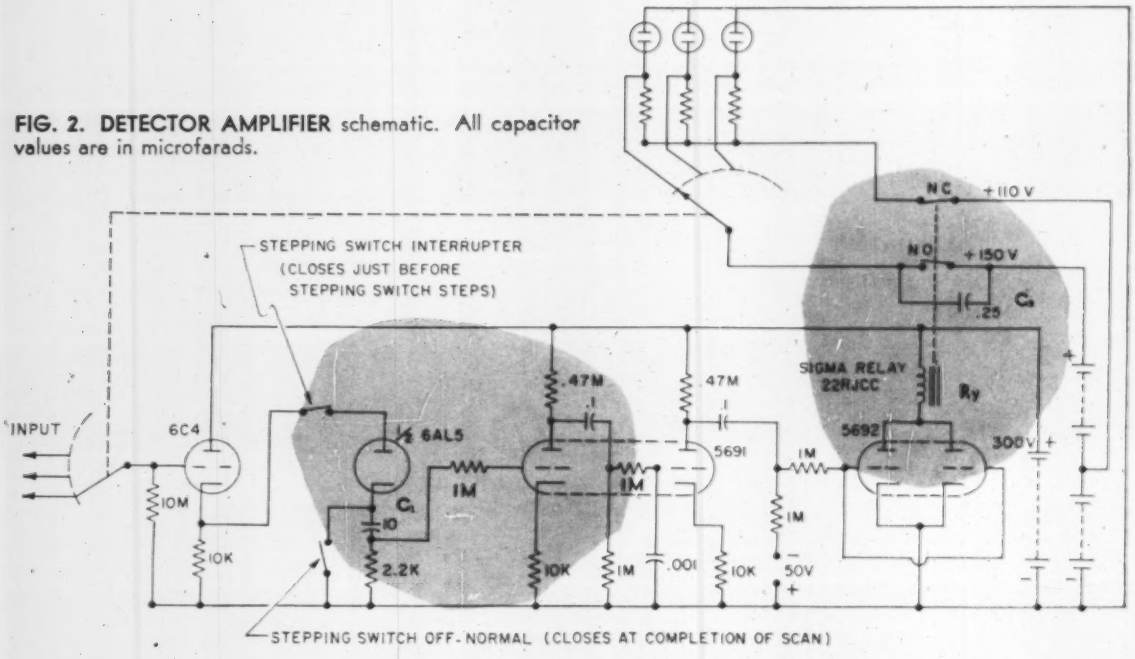


FIG. 2. DETECTOR AMPLIFIER schematic. All capacitor values are in microfarads.

stage (Fig. 2). The signal is applied to the plate of a 6AL5 diode through the stepping-switch interrupter contact. As the interrupter contact is closed only during the last half of the stepping-switch dwell-time on any point, switching transients are eliminated.

If the impressed voltage on the plate of the 6AL5 is positive with respect to the cathode, the tube conducts and the capacitor charges. If the impressed signal is equal to, or negative with respect to, the cathode, the tube does not conduct. This tube conducts only when the impressed signal is greater than the largest signal received previously. The charging time-constant of the resistor-capacitor network is 0.02 second. A premium quality capacitor (Stabelex D) is used for C_1, giving a discharge time constant greater than three hours. Thus C_1 holds a charge proportional to the highest signal received. This establishes the potential of the 6AL5 cathode that will remain essentially constant throughout the scan. Subsequent signals will not be amplified by the circuit unless they make the 6AL5 plate even more positive than the cathode (which is held by the charge on C_1).

Whenever the sampled signal does make the 6AL5 plate more positive than the cathode, then the voltage pulse developed across the 2.2 K resistor when the capacitor charge is being increased, is amplified by two triode stages and fed to the input of the power amplifier. The power amplifier uses two tubes in parallel to operate a Sigma relay. Whenever the relay operates it fires the lamp designated by the stepping switch.

As the relay (Ry in Fig. 1) is energized by the comparator circuit, it removes the holding voltage from the lamp panel, extinguishing any lamps that may be lit, and at the same time applies firing voltage through the stepping switch to light the lamp corresponding to the co-ordinate being scanned. The next stepping pulse moves the stepping switch to the next point in sequence, Ry drops out, and the holding voltage is applied, at least momentarily, to the lamps. The capacitor C_2 across the "fire" relay contacts keeps the newly fired lamp lit during the transit time of the contacts when the relay drops back to hold. If relay Ry is not re-energized, no change takes place on the lamp panel. If relay Ry is energized (by a subsequent higher input signal) the holding voltage is removed from the lighted lamp and firing voltage is applied to the bulb corresponding to the co-ordinate then being scanned. Now this lamp will remain lighted, because of the holding voltage, as the stepping switch moves to the next point. At the end of the scan, the one lighted lamp indicates the location of the point of maximum signal.

At the end of the scanning cycle a "Teflon"-insulated off-normal switch (on the stepping switch) is closed and discharges C_1 through the 2.2 K resistor. The circuit is now ready for a new scan that is initiated by pushing the reset button.

Any variable that can be converted into a d-c signal can be used with this system. It may be necessary to use a preamplifier on low-level signals to bring them up to the 10 volts or more necessary for proper operation of the detector. In the prototype, potentiometers fed with 100-v dc were used to simulate sensing elements. The detector operated successfully with as little as 0.5 volt differential between points.

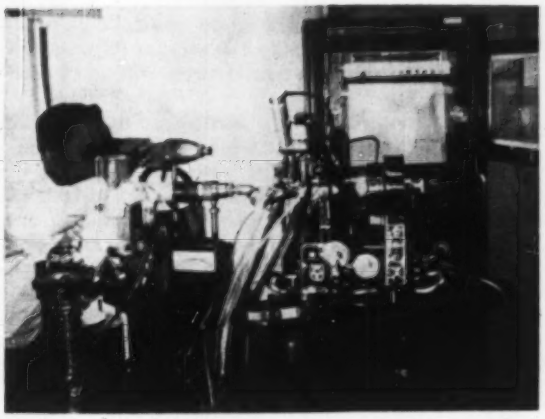


FIG. 1. RAYTHEON-DESIGNED high-temperature x-ray diffractometer.

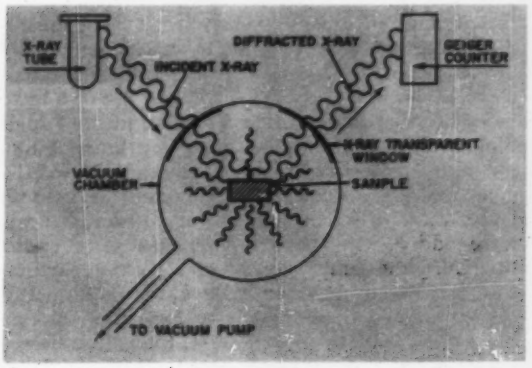


FIG. 2. DIFFRACTOMETER SCHEMATIC. Sample is in a vacuum of 10^{-6} mm Hg. A heating element around the specimen can bring the sample to any desired temperature up to 2000°C.

High-Temperature X-ray Diffractometer

Material phases and concentrations at elevated temperatures can be observed via x-ray analysis.

D. K. DAS
Raytheon Co.
Spencer Laboratory

IMPORTANT INFORMATION in materials research is the identity of the phases present and their proportions. X-ray diffraction (Fig. 1) yields much data on the state in which elements exist together. A simple way to obtain such information from a sample would be to continuously analyze it by x-ray diffraction while it is at elevated temperatures. This requires a high-temperature, x-ray diffraction camera.

The camera can be either the geiger-counter *diffractometer* type, or the photographic-film *Debye-Scherrer* type. The *Deybe-Scherrer* camera uses a small wire-shaped specimen located along the axis of a cylinder. The incident parallel x-ray beam enters the cylinder through a pin hole and irradiates the sample. The resulting diffraction spectrum is recorded on a strip of photographic film placed around the inside wall of the cylinder.

In the *diffractometer* type of operation, the sample is a flat surface irradiated by a divergent x-ray beam. The orientation of the specimen surface to the beam is varied through a range of angles. A geiger-counter measures the intensity of the diffracted beam at various angles to the sample surface. This data can be recorded by a strip-chart recorder.

It is desirable to analyze a sample while its temperature is raised, and to hold the sample at a certain temperature while the analyses are made at different time intervals. The diffractometer arrangement permits this easily, whereas it is difficult with the Debye-Scherrer camera.

Fig. 2 is a schematic diagram of the diffractometer. The 0.01" thick beryllium strips (sealed by O-rings) serve as the x-ray windows. The intensity loss in transit is about 10%.

The full angular range of a diffraction spectrum is from 0° to 180°. The closer the spectrum is to the 180° limit, the greater the precision in measurement. The range covered by the present diffractometer is from 10° on the low end to 100° on the high. The lack of high precision in cell-dimension measurements has not proved to be a handicap in following the course of reactions or transformations in the systems under study.

A number of high-temperature reactions have been investigated. For example, thorium carbide (ThC) is a constituent of some high-temperature cathodes. Although thorium and carbon react readily to form the compound, ThC reacts quickly with the moisture present in the atmosphere to form thoria (ThO_2). However, it was noticed

that if thorium carbide were formed from the reduction of thoria by less than the stoichiometrically needed amount of carbon, the resultant thorium carbide was extremely stable. It was interesting to speculate that thoria might be going in solid solution in the carbide lattice, imparting the stability.

The high-temperature x-ray camera provided the evidence. To a stoichiometric mixture of thorium and carbon, different amounts of powdered thoria were added. High-temperature runs were made, examining the sample continuously as the temperature was raised. At around 900°C the thorium and carbon combined completely to form thorium carbide. From 900° to about 1500°C the patterns were those of a mixture of thoria and the carbide. From 1500°C on, the intensity of thoria lines began to diminish, until at 1700°C they disappeared completely, leaving only the carbide lines. This proved conclusively that thoria does go into solid solution in the carbide. The thoria lines did not reappear on cooling. The maximum concentration of thoria used was 15%.

After a few trial runs, it was found that reliable measurements of brightness temperature of the diffractometer could not be obtained because of evaporation films accumulating on the surface of the viewing window. The movable shutter in front of the window was not a complete solution to this problem, especially at extremely high temperatures. The diffractometer temperature was, therefore, calibrated against power input, using a tungsten specimen with a narrow and deep hole. The temperature measurements were made with an optical pyrometer by sighting at the bottom of the hole, simulating the black-body condition and giving true temperature rather than brightness temperature readings.

TIMING SYNCHRONIZATION TO 10^{-6} SECOND

IN TIMING APPLICATIONS a problem exists in setting two or more clocks to agree with one another. The greater the requirement for agreement between the clocks and the greater the distance between them, the more difficult the problem becomes. Because of unpredictable variations in the rotation of the earth, the initial settings of individual clocks may differ by milliseconds. This system permits synchronization to microseconds.

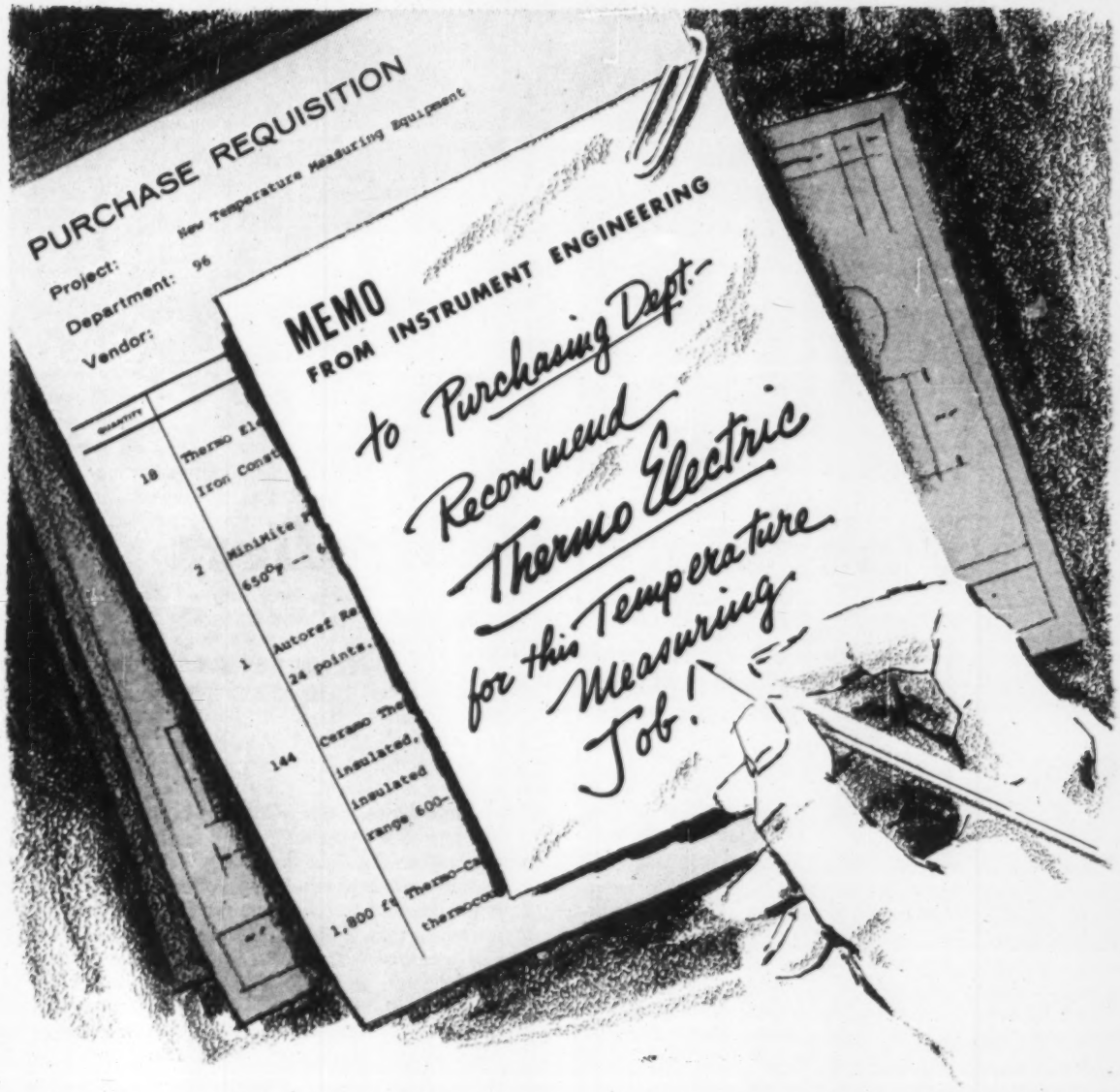
The system for synchronizing and setting widely separated clocks to a relative accuracy closer than a millionth of a second—a long-time goal as an aid to science—has been developed by the National Bureau of Standards and adopted by the Department of Defense. By synchronizing with a highly accurate uniform time source maintained at the Naval Observatory in Washington, D. C., the system can provide synchronized timing for the Armed Forces' coast-to-coast missile ranges, and the precise time necessary to further space-science progress.

In studies sponsored by the Ground Electronics Engineering and Installation Agency (GEEIA) of the Air Force, the Bureau's Boulder Laboratories scientists made an adaptation which uses signals from the existing long-range navigation system Loran-C.

The Loran-C clock system consists of a master clock at a convenient central location and other clocks at widely separated locations which are slaved to the master in such a way that each will track the master. The system provides for a means to synchronize each slave clock to agree accurately with the master. A set of Loran-C clocks will function as such a clock system with initial setting or synchronizing accuracies of a microsecond or better.

Precise timing applications include:

1. The positioning of high-altitude aircraft from the ground by UHF pulse technique.
2. Location of thunderstorms by measuring the location of lightning discharge.
3. Accurate position-fixing of nuclear detonations by a similar means.
4. Precise evaluation of the fluctuations of the periodicity of the earth's rotation and other astronomical phenomena by relating observations made at widely separated points.
5. Measurement of time variations on high-frequency transmissions such as WWV as an aid to better understanding of propagation phenomena.
6. Measurements on forward scatter communication links.
7. Surveying of offshore islands and remote areas.
8. Investigation of Loran-C sky waves to give a better understanding of low frequency ionospheric conditions.
9. Time from a single Loran-C clock could be made economically feasible for a variety of users in industry and research by the application of VHF or UHF distribution systems. Relatively inexpensive receivers would result if sufficient users were located within range of the distribution system. Existing facilities such as TV transmitters could be used for this purpose.



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Pneumatic Controllers

Here are the basic mechanics of on-off, proportional, and integral control with pneumatic control devices.

JOE N. KOVALY
Union Oil Co.

AUTOMATION sometimes is defined as the profession of measurement and control. Fortunately, all control systems can be reduced to common fundamental principles which are the same whether it be chemical process control or missile guidance.

The basic elements of a control system will include a measuring means, a controlling instrument, a final control operator, and a process (Fig. 1).

The measuring device measures the controlled variable and compares it to the set-point position of the controller. Any error between and two is detected by an error detector; the error signal is amplified and sent to the final control operator which will adjust the process input, thus affecting the controlled variable. The cycle is repeated until the process is brought into control (or there is no error between the measurement and set point).

The simplest controller uses on-off action. On-off control is suitable when process demand is small compared to the process capacity—such as low flows and large tanks. Controllers of this type satisfy approximately 60% of all industrial instrument applications.

In the pneumatic on-off controller shown in Fig. 2 air is admitted to the pneumatic system through a restriction that is about one third the size of the nozzle opening. As the baffle approaches the nozzle, a back pressure is built up in the system and applied to the final control element, thus effecting a change in the manipulated variable. This change is then reflected through the process and then back to the measurement. A movement of only 2 or 3

JANUARY MEETING NOTICE

Thursday, Jan. 19, 1961. Dinner 6:30; meeting 8:00 P.M. Rio Hondo Country Club, 10627 South Old River School Road, Downey, Calif. **Steve Kerstner**, the Foxboro Company, will present: ANALOG COMPUTER APPLICATIONS IN THE PROCESS INDUSTRIES. **E. G. Khougaz** of Computer Systems, Inc., will describe an high-speed rep-op analog computer and its applications.

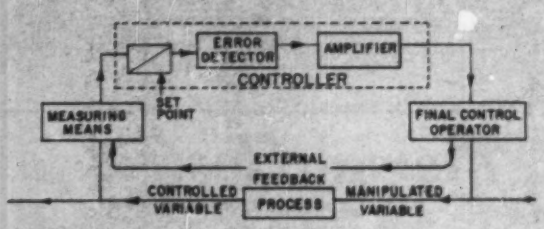


FIG. 1. BASIC feedback control system.

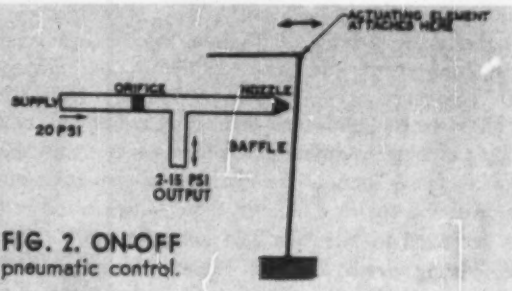


FIG. 2. ON-OFF pneumatic control.

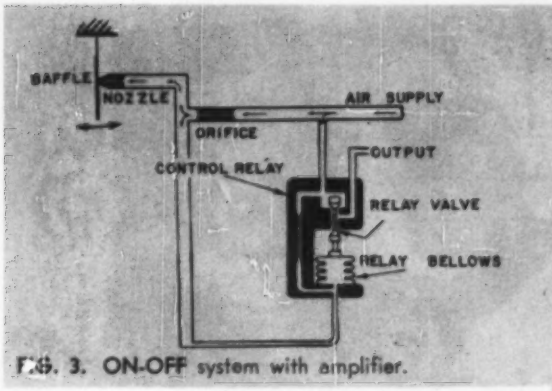


FIG. 3. ON-OFF system with amplifier.

thousandths of an inch of the flapper causes the pressure output to change through its entire range of about 2 - 15 psi. In a controller of this type the inflation and deflation time of the final control operator, the nonlinear relation of flapper movement to output air changes, as well as the nozzle blasting force on the flapper offer many disadvantages.

A pneumatic amplification system can offset these disadvantages. The mechanics of the error detector remain unchanged, but a pneumatic relay system has been added in Fig. 3. Air again is admitted to the nozzle through a restriction. The nozzle and restriction are sized so that a 2-4 psi back pressure will exist in the nozzle as the baffle covers and uncovers the nozzle. The nozzle back pressure is applied to the relay bellows to actuate a valve within the relay which can direct the 20 psi air supply to the final control operator. The amplification factor is the ratio of nozzle-back-pressure change to controller-output-pressure change.

Proportional Control

As processes become more complex and their demand-capacity ratios vary, there is need for a more flexible control system whose signal can be adjusted or "tuned" to the process. This is done by adding "feedback" as in Fig. 4.

In this controller, a bellows that repositions the nozzle has been added to the nozzle system. When the measurement unit moves, (or if the set point is moved to a new value) the flapper is moved. This changes the air signal (output) from the nozzle system. This output pressure is imposed on the bellows. The bellows causes the nozzle to move in such a direction as to oppose original motion. The result is an output pressure that is linear and *proportional* to the motion of the measuring unit. The adjustable pivot provides the means of controlling nozzle follow-up and thus establishes a select ratio of input to output. The percentage of full-scale deviation of the pen that results in a full output-pressure change of the controller is expressed as % throttling or % of proportional band. The narrower the throttling band (towards 0%) the higher the sensitivity of the controller. Note: In a proportional controller there is only one position of the final control element for each position of the measurement variable (for a given position of the set point and the adjustable pivot of the follow-up device).

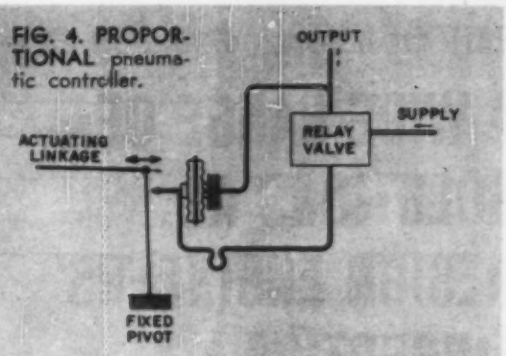


FIG. 4. PROPORTIONAL pneumatic controller.

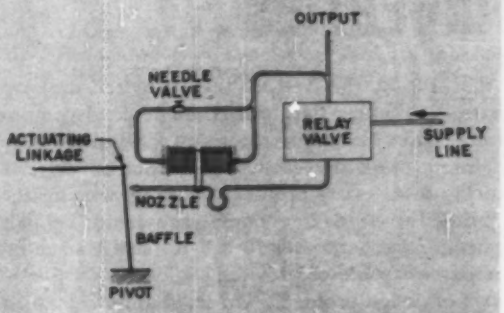


FIG. 5. PROPORTIONAL-with-reset pneumatic controller.

Reset

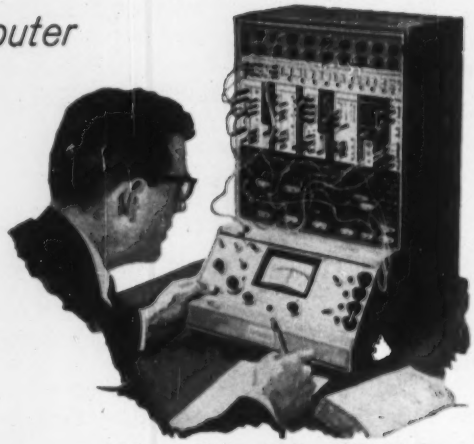
One of the undesirable features of a controller with only proportional action is that the process can be balanced at a control point which is different from the set point of the controller. This is due to the changes in demand of the process, usually referred to as *load changes*. The difference between the control point of the process and the set point of the controller is known as *offset*. In processes that require control to a specific set point, further refinement of our controller must be made (Fig. 5).

The basic configuration of the internal and external feedback control loop remains unchanged except for the modification of the internal feedback system within the controller.

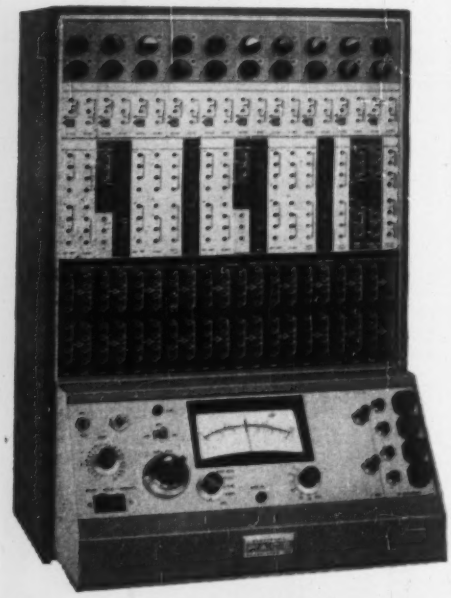
The modification is the addition of a bellows to oppose the proportioning bellows. The effect of this bellows is to provide a positive feedback that is additive to the error signal. If the functioning of the proportioning bellows is to position the nozzle within the throttling position of the error detector, then, by adjusting the opposition to the proportioning bellows with the reset bellows, this throttling position can be shifted to some other value to make the control point of the process coincidental to the set point. The resulting effect of *reset* in a controller is to change the position of the final control element to some other value depending on the demand or load changes of the process. Note that reset in a controller is a function of time, while proportioning governs the magnitude of the output pressure change. This is because it takes time for the pressure to build up in the reset bellows owing to the needle-valve restriction.

EAI *Transistorized Analog Computer*

A WIDE RANGE OF SOLUTIONS AT DESIGN ENGINEERS' FINGERTIPS...



PACE® TR-10, the first all transistorized desktop analog computer, puts proven high-speed computation right where it's needed – on the desks of busy engineers. With this easy-to-use simulator, you can quickly solve many problems without waiting for scheduled access to large-computing systems. Though compact in size, the TR-10 is a full-fledged analog computer capable of providing solutions to a wide range of design problems. Up to 20 amplifiers, plus linear and non-linear computing components are contained in one compact cabinet with no external racks. The TR-10 permits rapid evaluation of different design approaches. It demonstrates the performance of a conceptual or drawing-board design prior to construction. Thus it saves time and money normally required for multiple test models with cut-and-try engineering.



Here's How The TR-10 Saves Engineering Time

The TR-10 is especially useful in solving problems in such diverse areas as servo-system design, heat flow, chemical reaction analyses, suspension systems studies and many other problems involving dynamic conditions. Fast answers to problems posed by new design ideas immediately determine feasibility of projects. With the TR-10, engineers can explore new ideas as they occur – concentrate valuable time on the most promising area of study.

(Applications notes are available describing typical problem solutions.)

How Do You Use The TR-10?

First—Represent in equation form the physical system to be studied.

Second—Select through a simple computer diagram the computing components required to perform the calculation (programming).

Third—Interconnect these components on the computer (problem patching) and set problem parameters with adjustable controls.

Fourth—Run the problem with results presented graphically on an accessory recorder or oscilloscope.

You now have an electronic analog *model* of the physical system under study. You can manipulate design parameters quickly, running comparative solutions without becoming involved in repeated calculations. With the TR-10 you can rapidly develop truly optimum designs.

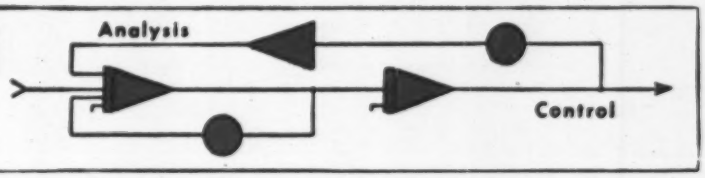
For complete details of TR-10, write for free copy of Bulletin CC821-A.

PACE TR-10 Analog Computer, including components for addition, subtraction, multiplication, division, integration and generation of powers, roots, logs, antilogs and arbitrary functions.

EAI ELECTRONIC ASSOCIATES, INC. *Long Branch, New Jersey*

CIRCLE 58 ON READER-SERVICE CARD

SIMULATION COUNCIL



Newsletter

John H. McLeod Jr., EDITOR

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Bits

This month only one letter! Doesn't anyone *care* what we say? But under *Pieces* we give you the story on the Eastern Simulation Council meeting at Morristown, New Jersey (Esso Research & Engineering) last May.

Subject of the meeting was "Analog Computing in Process Simulation," with talks as follows:

"The Use of Simulation in Batch Control Problems" by *Mort Hausner;*

"Use of Varistors for Function Generation" by *Ivan Gruet;*

"Simulation versus Optimization" by *William Drews;*

"The Use of Memory Channel for Fixed Bed Systems" by *R. G. E. Franks;*

"Statistical Studies" by *Art Rubin.*

One "He Went," a little "Info," and a bit of reminiscing under "Thot" completes this December *Newsletter.*

Pieces

EASTERN S/C MEETING OF 16 MAY ON "ANALOG COMPUTING IN THE PROCESS INDUSTRIES"

Bill Blodgett, Secretary-Treasurer of the Eastern Simulation Council, writes that more than 100 members attended their May 16 meeting at the "quiet and college-like Esso Remote Center" just outside Morristown, New Jersey. "Truly an ideal setting" says Bill; however, he attributes the large attendance to the subject, "Analog Computing in Process Simulation".*

The first paper of the meeting was "The Use of Simulation in Batch Control Problems" by *Mort Hausner* (Fischer & Porter Co., Hatboro, Pennsylvania). "This paper," writes Bill, "described the use of general-purpose analog-computing equipment in studying an industrial process-control system where the time constant for the process was very long." Sounds interesting, but unfortunately we have no other information on the presentation.

Gruet on Varistors For Function Generation

The next talk was "Use of Varistors for Function Generation" by *Ivan Gruet* (Esso Research & Engineering Co., Florham Park, N. J.) Bill enclosed a copy of that paper, so we present it herewith almost verbatim:

Stimulated by an interesting presentation given by General Electric before the Eastern Simulation Council a year ago, the analog-computer group at Esso Research & Engineering Company decided to investigate the possible use of varistors for function generation in conjunction with amplifiers and potentiometers.

The results were presented somewhat as follows:

I. Definition

A varistor is a passive element with a resistance inversely related to the input voltage. As the input voltage increases, the resistance decreases. This nonlinear characteristic makes the varistor valuable in function generation.

II. Use of Varistors with Operational Amplifiers

1. The first attempt at function generation was made by using varistors at the input of an operational DC amplifier with a one-megohm

*See (After) Thot at the end of *Newsletter.*

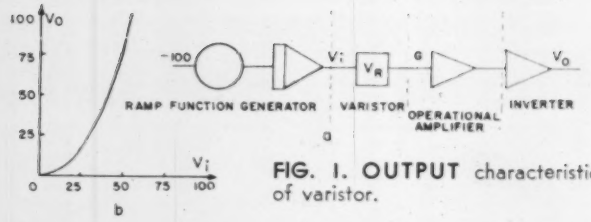


FIG. 1. OUTPUT characteristic of varistor.

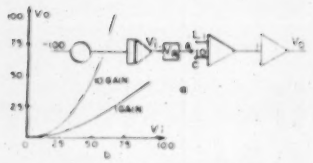


FIG. 2. GAIN effect.

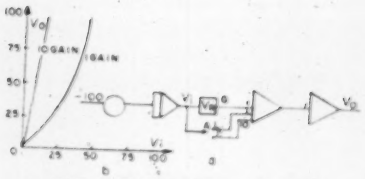


FIG. 3. PARALLEL effect.

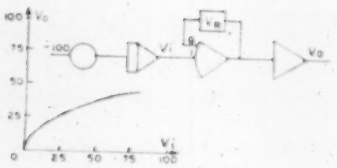


FIG. 4. FEEDBACK effect.

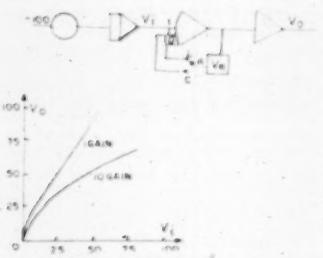


FIG. 5. FEEDBACK effect.

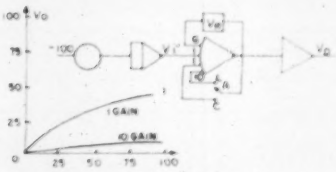


FIG. 6. FEEDBACK effect.

feedback resistor. The curves of Fig. 1b show the variation of output versus input voltages when the varistor is connected directly to the grid of the amplifier, as shown in Fig. 1a. When the varistor is connected in series with a 1 or 0.1 megohm resistor, as shown in Fig. 2a, the input/output curve is as shown in Fig. 2b. In parallel with a 1 or 0.1 megohm resistor, as shown in Fig. 3a, the curves are of the form shown in Fig. 3b.

All these curves are exponential. However, each varistor will give a different basic exponential curve. The coupling of different input resistors with varistors gives an interesting fanning effect showing the possibility of generating any constantly rising exponential curve.

2. Corresponding curves, (symmetrical with respect to a 45° line) are obtained when the varistor is in the feedback path of an amplifier and the input voltage is fed to a 1-megohm input resistor, as shown in Figs. 4, 5, and 6.

When generated with different varistors, the curves shown can be summed algebraically to give an almost limitless number of functions.

III. Function Generation with Two Different Varistors Used Respectively in the Feedback Path of Two Operational DC Amplifiers

As has been shown, the two amplifiers' outputs will be exponential. Using potentiometers as weighting factors, the outputs can be subtracted from one another and added to ramp functions. By varying the pot settings, the following curves can be obtained with two separate inputs:

1. *Using a ramp function as an input to the varistor circuit*

a. Two-cycle sine wave

b. Bell-shaped functions asymptotic to the t axis at $t = \infty$ (often encountered in chemical reaction problems)

c. S-shaped curves, characteristic of the integral of a probability distribution function

d. Any exponential curve

e. Exponential-type curves with half-cycle type oscillations in the flatter part of the curve

f. Rotation of the S curve to get dead time by laying the sharp-rising part of the S curve on the X axis

g. Perfect duplication of log X curves when compared to the regular fixed diode function generator card output

h. Close approximation of X^2 curves as generated by fixed function cards

i. Very close approximation of branches of parabolas and hyperbolas

j. Close approximation of tangents, co-tangents, hyperbolic sines, and cosines

k. If the two-cycle sine wave is integrated and the output of the integrator plotted versus the output of the varistor circuit, a whole family of cycloids may be obtained.

2. *Using a sine wave as an input to the same two-varistor circuits*, one obtains:

a. A sine wave of same frequency but with different amplitude

b. A sine wave identical to the sine wave but soft-limited to any desired value

c. A sine wave with the same frequency as the input sine wave but with a phase shift of 90°

IV. Advantages and Disadvantages of Varistor Circuits

1. *ADVANTAGES*

a. **Generation of smooth curves**—All function generators used prior to the use of varistors gave a segmented approximation of the desired arbitrary curve. These segments caused errors and instability in some problems. This is particularly true of the fixed diode function generator cards and the quarter-square multiplier cards.

b. **The frequency response** of the varistor circuit is only limited to the frequency response of the amplifier(s), which is already quite high and offers no limitation in high-speed repetitive operation.

c. **Less hardware** is required in connection with varistors to generate a large number of functions.

d. **Less setup time** is needed during the initial fitting of arbitrary curves. Our experience so far has been that within twenty minutes the desired curve can be obtained. Further resettings of the same curve can be made extremely fast since all that is required is essentially the setting of two or three potentiometers.

2. *DISADVANTAGES*

a. The varistors as reported by General Electric are sensitive to temperature. Varistors may be off as

much as 0.7% per degree centigrade. Therefore they should be mounted in an oven, and the generated curve should be plotted for verification at least once a day.

b. No two varistors are identical. However, this is not much of a drawback in function generation because the varistors are generally used in conjunction with potentiometers and fixed resistors which allow compensation.

V. Proposed Future Use of Varistors.

In the light of the interesting results obtained, it was suggested that a possible use of the varistor would be in fixed function generator and quarter-square printed circuits. This should (1) remove all sharp breaks from the output curves, and (2) give better precision at low voltage levels.

Drews on Simulation Vs Optimization

"Simulation versus Optimization" by *William P. Drews* (Esso Research & Engineering Co.) was the third presentation. According to Blodgett, "Bill indicated that it was possible to go from simulation to optimization by transfer of some variables out of the mind of the programmer into the computer. It was pointed out that through investigation it had been determined that a human can handle about five variables."

We are sorry no additional comments were forwarded to us on this talk. Fortunately we do have a copy of the next paper, "The Use of Memory Channel for Fixed Bed Systems" by *Roger G. E. Franks* (E. I. Dupont, Newark, Delaware), which we present herewith almost as written.

Franks on Memory for Fixed-Bed Systems

Analog/Digital Memory Application to Fixed Bed Transients

A digital memory channel is a device that will store a set of numbers. For analog solution of certain types of problems (e.g., partial differential equations), these numbers can represent successive values of a time variable, as shown in Fig. 7.

The original function c(t) (shown as a solid curve in Fig. 7) could be reproduced with satisfactory accuracy by linearly interpolating between the stored numbers n_1, n_2, etc.

The memory channel is "driven" by two signals from the analog computation, namely a time voltage and the time-dependent value c(t), as shown in Fig. 8.

At preselected values of time (t_1, t_2, etc.) the memory will store the successive values of c(t). At the end of the run it should be possible to drive the memory channel with t (starting from t = 0) and reproduce the linearly interpolated function c(t). In other words, *this is the definition of an automatically-set function generator.*

FIG. 7. N = f(t).

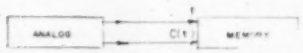


FIG. 8. MEMORY is driven by t and c(t).

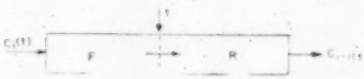


FIG. 9. FORWARD (F) AND REVERSE (R) memory.

A more generally useful memory has the capability of storing a new function while at the same time reproducing a previously stored function.

Such a memory would consist of two parts, a forward (F) and reverse (R) memory, as indicated in Fig. 9, the former storing the result $c_i(t)$, currently being produced, while the latter reproduces the previous result $c_{i-1}(t)$. Transfer of $c_i(t)$ from the forward to reverse memory can take place any time after $c_{i-1}(t)$ has been used.

The greatest value of such a device is realized when it is necessary to use the result of a previous computation for a fresh computation, thus requiring rapid storage and reproduction of a function. The technique is applicable to a number of problems in chemical engineering, and especially to composition transients through fixed beds (kinetics, absorptions, adsorption, diffusion, heat transfer, etc.) A typical example is a fixed-bed ion-exchange process where a solution containing a component A is passed through a fixed resin bed which will absorb the A component until the resin absorption capacity is exhausted. At this time the effluent solution concentration of A will start to increase up to the maximum inlet concentration A_o. A mathematical model programmed for computer solution allows an investigation of the effect of varying the system parameters such as solution flow rate, bed depth, resin properties, etc.

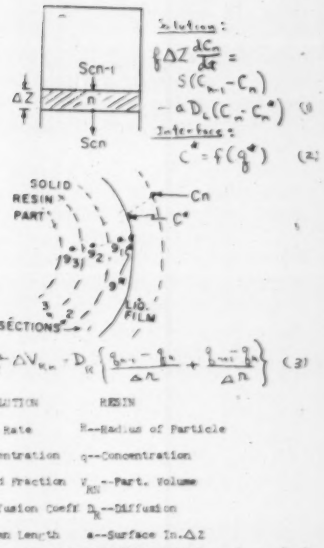
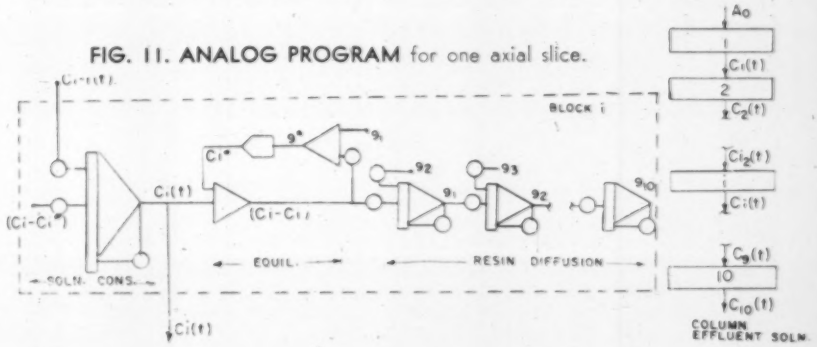


FIG. 10. DIFFERENCING of radial and axial variables.

The complete system is defined as a set of partial differential equations with three independent variables—time, axial length (down the column), and radial length (diffusion into the resin bed). Finite differencing the radial and axial variables into 10 segments, as shown in Fig. 10, the analog program for one axial slice is shown in Fig. 11, which also indi-

FIG. 11. ANALOG PROGRAM for one axial slice.



cates the over-all scheme. Since 11 integrators are required for each axial slice, a total of 110 integrators would be required for a simultaneous solution of the entire bed, which makes this approach somewhat impractical.

However, since the program in each axial slice is the same for all slices, and there is only one signal c(t) (solution concentration) passing forward, the entire computation could be made possible by programming just one slice and passing the result of the computation $c_1(t)$ to a memory channel. Resetting the analog and starting again with this stored $c_1(t)$ as the driving function, a new $c_2(t)$ is produced—which is in turn stored and used again, and so on.

A typical result for an ion exchange column is shown in Fig. 12.

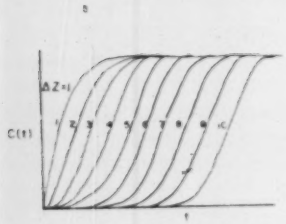


FIG. 12. RESULT for an ion exchange column.

This method requires only 11 integrators plus the integrators required for the memory channel. The main disadvantage is that more time is needed to complete each run because the entire bed has to be computed serially slice by slice. On the other hand, the method reduces considerably the amount of computation equipment required, in this case a 75% reduction of integrators and a 90% reduction in nonlinear equipment. An even more important advantage exists for problems where a parameter search is involved, as there are considerably fewer potentiometers to be reset (in this case only 1/10 as many).

Figs. 13 and 14 show two schemes for a practical memory channel which can be put together for the analog computer using components already available, except that the second example requires a stepping switch. (However, the stepping switch eliminates the need for 17 relays and amplifiers.) The memory channel consists simply of a set of sample-clamp circuits operated sequentially by either operational relays or a stepping switch. In both cases the forward memory consists of a bank of capacitors, while the reverse memory is composed of the integrators. The linear interpolation is obtained by connecting the output of the integrators to the taps on a servo cup and driving the servo by the time signal t. As soon as the servo arm has passed a given segment, the forward memory capacitor can be discharged into the integrator. This double action explains the cross-connection in the stepping-switch bank and the double set of relay contacts in the relay-type memory.

Though the circuit is not shown, both memories are programmed to be entirely automatic as to cycling through each run, resetting, lifting and lowering the plotter pen, and so on.

Rubin on Statistical Studies

Arthur Rubin (EAI Computation Center, Princeton, N. J.), the last speaker of the day, changed the title of his talk, which had been billed as "Continuous Data Analysis Using Regression Techniques," to "Statistical Studies."

We have Arthur's own word for the fact that this talk showed how certain fundamental statistical quantities such as the mean, the variance, the autocorrelation function, the cross-correlation function, the Fourier transform, and the power spectrum can be estimated continuously by simple analog techniques.

Fig. 15 shows a circuit for estimating the mean f_a of a continuous signal f(t), where f(t) is proportional to the variable x, and the variance σ_a.

Note that σ_x will be a continuous function of time and represents the "best" value of x over the past three time-constants determined by α, where α is the reciprocal time-constant of interest. This can be adjusted from problem to problem.*

Correlation circuits were not shown because these were discussed by *Ian Hay* at the October 1959 Eastern Simulation Council meeting and were written up in the May 1960 *Newsletter*.

A circuit for estimating the power spectrum at ω and its "in phase" Fourier component and its "out of phase" Fourier component are shown

*See, for example, J. Otterman's "Properties and Methods for Computation of Exponentially-Mapped-Past Statistical Variables," *IRE Transactions on Automatic Control*, Vol. AC-5, January 1960.

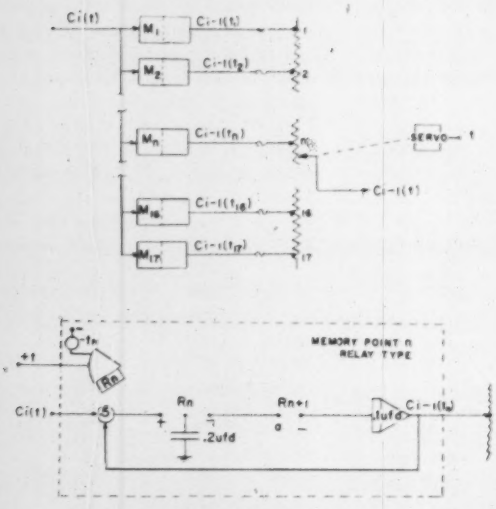


FIG. 13. MEMORY channel.

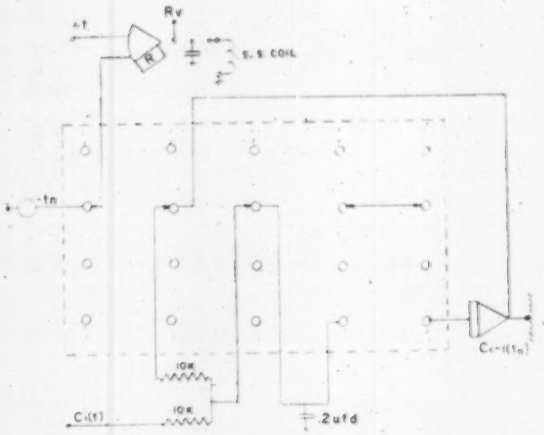


FIG. 14. MEMORY channel using stepping switch.

in Fig. 16, where $P_a(\omega)$ is the estimated power spectral density at ω of the input signal f(t).

Note that the foregoing concerns estimating parameters of a single population. If it is necessary to try to relate two or more different populations, the statistician uses "regression" techniques. The "least squares" fitting of a straight line to a set of data points is an example of linear regression.

As an illustration of how least-squares fitting would be performed on the analog computer, let us consider the following linear case. The general equation is

$$Y = m\,x + b \qquad (1)$$

From the general equation (1) it can be shown* that the following two equations will define the unknown parameters m and b, the slope and intercept of the line, respectively

$$\sum_{i=1}^{n} Y_i = m\sum_{i=1}^{n} X_i + nb \qquad (2)$$

$$\sum_{i=1}^{n} X_i Y_i = m\sum_{i=1}^{n} X_i^2 + b\sum_{i=1}^{n} X_i \qquad (3)$$

Now since Y and X will be a continuous functions of time, because they represent a continuous trajectory, the discrete summation from 1 to n can be replaced by a time integral, where the total time t is proportional to n. We can therefore write

$$\int_0^t y\,dt = \sum_{i=1}^{n} Y_i \qquad (4)$$

$$\int_0^t X\,dt = \sum_{i=1}^{n} X_i \qquad (5)$$

$$\int_0^t XY\,dt = \sum_{i=1}^{n} X_i Y_i \qquad (6)$$

$$\int_0^t X^2\,dt = \sum_{i=1}^{n} X_i^2 \qquad (7)$$

Substituting (4), (5), (6), and (7) into (2) and (3):

$$\int_0^t Y\,dt = m\int_0^t X\,dt + bt \qquad (8)$$

$$\int_0^t XY\,dt = m\int_0^t X^2\,dt + b\int_0^t X\,dt \qquad (9)$$

(8) and (9) can be solved simultaneously to yield m and b as follows:

$$b = \left(\int_0^t Y\,dt - m\int_0^t X\,dt\right)/t \qquad (10)$$

$$m = \left(\int_0^t XY\,dt - b\int_0^t X\,dt\right)/\int_0^t X^2\,dt \qquad (11)$$

Note that if different weighting is assigned to each point of (2) and (3) they become

$$\sum_{i=1}^{n} W_i Y_i = m\sum_{i=1}^{n} W_i X_i + b\sum_{i=1}^{n} W_i \qquad (2a)$$

$$\sum_{i=1}^{n} W_i X_i Y_i = m\sum_{i=1}^{n} W_i X_i^2 + b\sum_{i=1}^{n} W_i X_i \qquad (3a)$$

and we can then change (4) through (7) to be

$$\int_0^t WY\,dt = \sum_{i=1}^{n} W_i Y_i \qquad (4a)$$

$$\int_0^t WX\,dt = \sum_{i=1}^{n} W_i X_i \qquad (5a)$$

$$\int_0^t WXY\,dt = \sum_{i=1}^{n} W_i X_i Y_i \qquad (6a)$$

$$\int_0^t WX^2\,dt = \sum_{i=1}^{n} W_i X_i^2 \qquad (7a)$$

and of course

$$\int_0^t W\,dt = \sum_{i=1}^{n} W_i \qquad (12)$$

The final analog computer equations for obtaining the least squares line, including non-linear weighting, become

$$b = \left(\int_0^t WY\,dt - m\int_0^t WX\,dt\right)/\int_0^t W\,dt \qquad (13)$$

$$m = \left(\int_0^t WXY\,dt - b\int_0^t WX\,dt\right)/\int_0^t WX^2\,dt \qquad (14)$$

An unscaled analog-computer circuit for the solution of (13) and (14) is shown in Fig. 17.

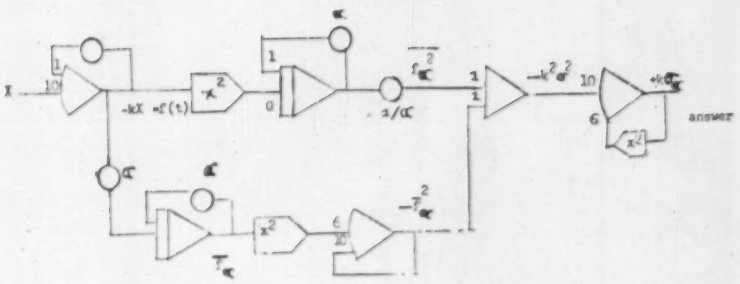
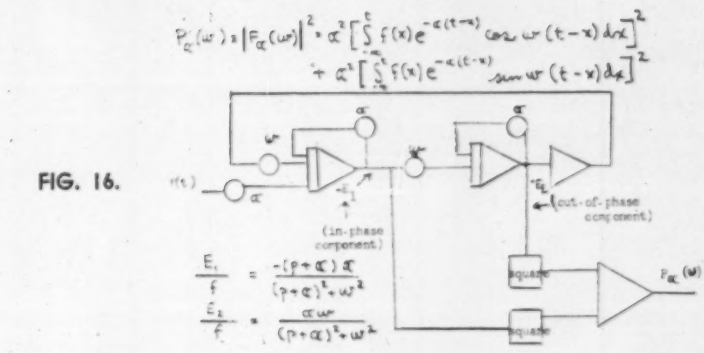


FIG. 16.



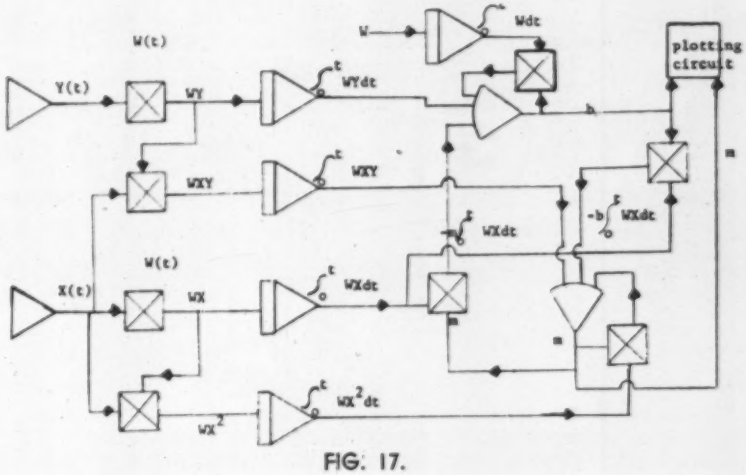


FIG. 17.

Statistical Methods, H. Arkin, R. Colton, Fourth Edition (Revised 1950), Barnes and Noble, New York.

Dr. Leland G. Cole
Vice President – Research, Beckman Instruments, Inc.

Dr. Arnold O. Beckman
President – Beckman Instruments, Inc.

Dr. Maxwell C. Gilliland
Director of Research – Berkeley Division

Leadership in analog computation . . .

is a vital part of a progressive company like Beckman Instruments. Leadership of this division must be consistent with total Corporation leadership to assure the constant advancement of such arts as analog computation and advanced digital instrumentation. Thus the kind of top technical management which is guiding a fast growing corporation is also reflected in the management of our Advanced Research Department.

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INSTRUMENTAL IN YOUR FUTURE

Z1

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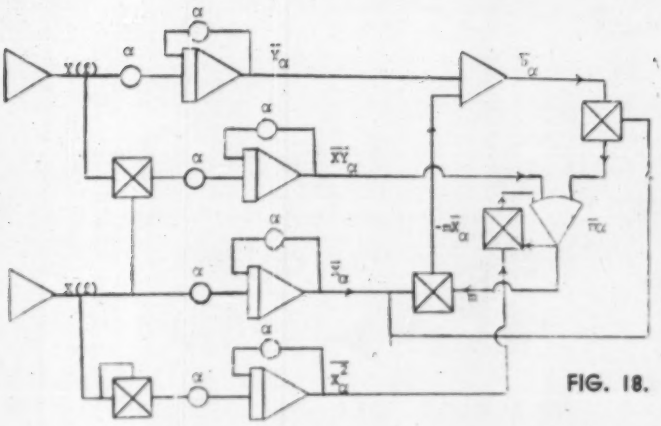


FIG. 18.

Once the best values of b and m have been determined, which would be within a second or two after the end of the missile run, a separate plotting circuit could then plot the line $Y = mX + b$.

Extension of this technique to quadratic curves is easily accomplished with the addition of more parameters. For example:

$$Y = a + bX + cX^2$$

is the general expression for a parabola and has three unknown parameters. Three equations similar to (2) and (3) can then be written to find a, b, and c. These in turn can then be easily converted to continuous integrals such as (4) through (7).

The circuits described previously used the definite integral. To convert to EmP (exponentially-mapped-past) variables, as referenced, divide equations (2) and (3) by n, yielding

$$\Sigma y_i/n = m\Sigma x_i/n + b \quad (2b)$$

$$\Sigma x_i y_i/n = m\Sigma x_i^2/n + b\Sigma x_i/n \quad (3b)$$

Now define the summations divided by n as EmP variables:

$$\Sigma y_i/n \equiv \overline{Y}_\alpha$$

$$\Sigma x_i/n \equiv \overline{X}_\alpha$$

$$\Sigma x_i y_i/n \equiv \overline{XY}_\alpha$$

$$\Sigma x_i^2/n \equiv \overline{X_\alpha^2}$$

and draw a new circuit diagram, as shown in Fig. 18, solving equations (2b) and (3b) for m and b, except that the results are now the EmP estimates of m and b, namely m_α and b_α.

Info (Without Theory)

We note that our friends of distinction*, Electro Precision Corporation of Arkadelphia, Arkansas, are now offering a 10-amplifier stabilized "Collegiate" analog computer as well as miscellaneous components. How many does this make in the field now?

• • •

In the past we've often published free "Help Wanted" ads for the benefit of our readers, so now that the situation warrants it, why shouldn't your Ed. do the same for his benefactor*, that eminent dealer in missiles and satellites, that makes it possible for him to live in "La Jolla, Jewel of the Pacific?"

In other words we—my colleagues in my own group—need help! So if you know any qualified worker who would like to move to this vicinity and get into the "space race," *please let us know!*

By "qualified workers" we mean people who have a strong analytical background of training and experience in engineering, mathematical physics, and/or applied mathematics, and who are anxious to dig into the details of practical guidance and over-all systems problems (using computer techniques as required) for solutions that are directly usable for actual flights or real space vehicles.

• • •

We said we didn't get a letter this month, but actually we did, brief and to the point to the extent that we got involved with the enclosure and, until now, forgot the letter. It simply said:

> Enclosed is a preliminary proposal on standardization of Swedish, Danish and Norwegian terminology, used in connection with analog computers. We thought it might interest you.
>
> *Sten Axelsson*
> *Scandinavian Analog Computer Society (SAMS)"*

Your Ed., being no linguist at best, and a linguistic ignoramus (including English, at worst, almost sent the "SAMS STANDARDISERINGS-KOMMITTE Rapport nr 2" to the Astro library without opening it. But, whatdoyouknow, my curiosity got the best of me and I found I could almost —well somewhat—read it.

For instance, an integrator in Danish is an integrator, in Norwegian an *integrator*, in Swedish an *integrator* in "Tysk" (whatever that is) an *integrator*. But in French it is an *intégrateur!*

But with a coefficient potentiometer it is different. In Danish it is a *koefficient-potentiometer*, in Norwegian a *koeffisient-potensiometer*, in Swedish a *koefficient-potentiometer*, in French a *potentiomètre*, and in Tysk a *Potentiometer*.

But don't relax. In "Dansk" an input gain is a *forstaerkningsfaktor*, in "Norsk" a *forsterkningsfaktor*, in "Svensk" a *förstärkningsfaktor*. The "Fransk" explain it simply as *"gain d'entree d'un amplificateur,"* but not to be outdone the "Tysk" refer to it as *"Eingangsverstärkung eines Verstärkers."*

Anyway, they are standardizing—wish we could do the same!

(After)Thot

Early in November of 1952 a comparatively small group of people met at the Colonial House in Oxnard, California, and the Simulation Councils were born. At the same time we decided to publish a *Newsletter*. (We wonder how many who were there still read it?)

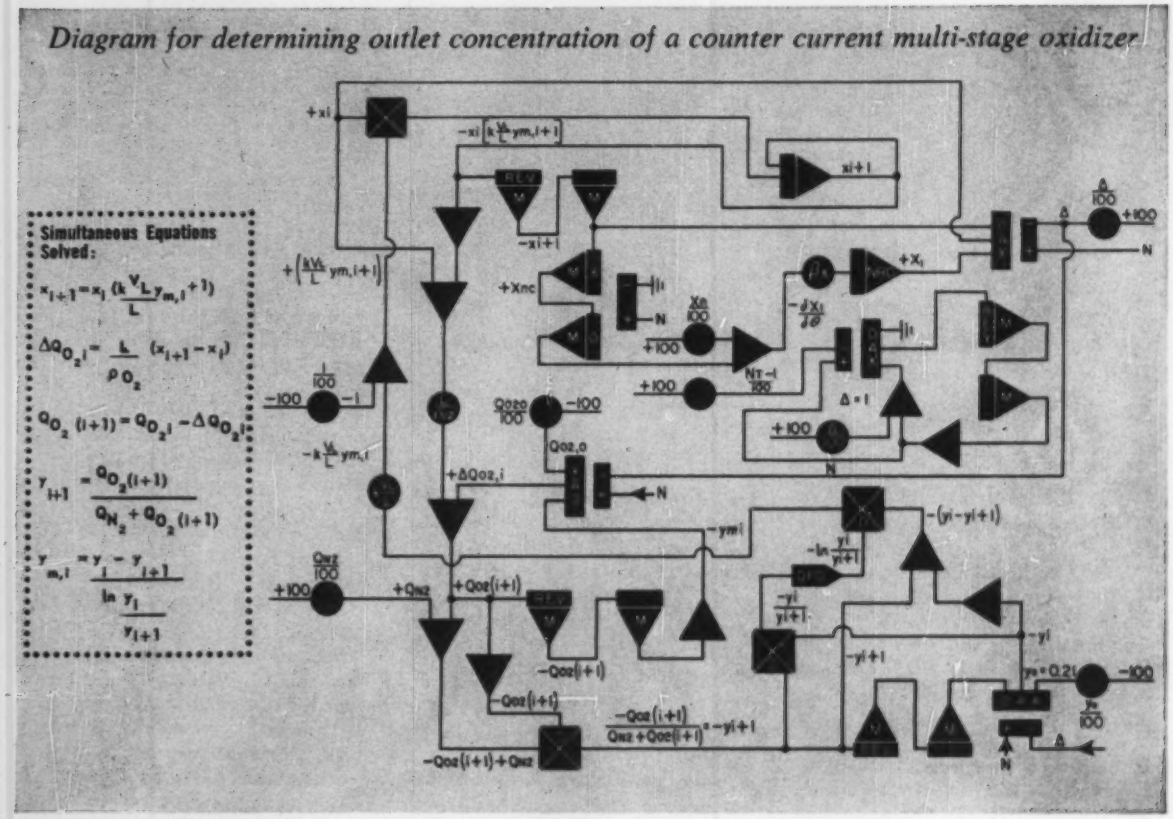
The success of this and subsequent Simulation Council activities led some of us to believe that by 1954 the time was ripe for a related organization to serve those interested in the application of computers to the control of automatic processes in industry. So the Industrial Analysis and Control Council was organized. But after two meetings it died.

The Coroner's jury brought in a verdict of malnutrition. The meetings were well attended and interesting, but there was no meat. Every one had

*Distinction: The only company (as far as we know) building computers in Arkansas.

**Convair—Astronautics

Diagram for determining outlet concentration of a counter current multi-stage oxidizer



Multi-Stage Oxidation Problems Solved in Seconds with DYSTAC Computer!

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Whether your problems are dynamic or static, covering costs, design or production control in: Operations Research, Chemical Kinetics, Structures or Hydrodynamics, DYSTAC can solve them faster, more accurately and more economically than any other computer.

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an appetite for learning but could not, or would not, contribute grist for the mill.

Now, six years later, consider the difference.

One (an editorial euphemism for "you") cannot now go to a technical session of any kind that is concerned with automatic control, industrial processes, computers, or any related subject without being exposed to papers on computer control of industrial processes. And most of the papers are nourishing—no malnutrition now!

And more to the point, our own Simulation Councils are in the forefront of this awakening. So why didn't it work six years ago? Is there a moral here? Or at least a lesson??

Flash—

We are pleased to announce that our longtime friend and consistent supporter *Dr. William J. Schart,* Chief of Engineering Computer Labs., Convair-San Diego, has earned, without collusion of any sort (except perhaps by a speedy secy, and the Post Office Department) the distinction of being the first dues-paying member of the Simulation Councils Incorporated. His was the first check received —but fortunately we now have a good many more. *Is yours among them?*

John

He Went Thataway!

Our friend *Tim Sutton* writes that he's now General Sales Manager for Tensor Electric Development Co., 1873 Eastern Parkway, Brooklyn 33, New York, with some computer work involved in his new job. Besides being an authority on computers, Tim is notable for having been recognized as an old friend by a sea lion that he —and your Ed. and Secretary—once encountered (in a bath tub!) near Ensenada, Mexico. Tim never would tell us, though, where he and the sea lion had met before!

Letters To Your Ed.

"Dear John:

1. This is about the survey requested in the March Simulation Council *Newsletter.* I vote as follows:
   (a) Wine and meat, if at all possible. Not only is this more enjoyable, but, I believe, more informative.
   (b) Abstracts are the next choice. Possibly you can simulate some wine by a liberal insertion of additional remarks and opinions, based on your own knowledge of the people and/or subjects. One italicized paragraph of yours following every sentence of the abstract would be about the right proportion!
   (c) Reprint full text only if (1) you have nothing else available, *and* (2) you don't have the time to abstract them, *and* (3) in *your* opinion they are "significant".
2. Keep up the excellent work. Possibly by sufficient needling, you can train some of the local secretaries to become "wine and meat" suppliers, or, possibly, you can pick your own correspondents (to the great relief of the local secretaries). I will bet that lots of them are not aware how much fun it is to write up a meeting from a commentator's point of view.*
3. Have you ever seen the enclosed publication?** We have several San Diego subscribers.

Francis V. Wagner, Group Leader
Engineering Computing Group
North American Aviation, Inc.
Los Angeles 45, Calif."

Of course your Editor likes the above letter. Anyone for polemics?

*Secy's and prospective cores—ah, that is, correspondents—please note.

**DATA-LINK, published 10 times a year by the Los Angeles chapter of the Association for Computing Machinery. Subscription price is $3.00 a year to non-members. The issue Frank sent us was 10 mimeo pages of general and local news of digital computers and people.

Computer Events

★ **AIEE-IRE-ACM**
Eastern Joint Computer Conference

Hotel New Yorker
New York, N. Y.
13-15 December 1960

★ **Combined Analog-Digital Computer Systems Symposium**

Sponsored by Simulation Councils, Inc., and Missile and Space Vehicle Dept. General Electric, Phila, 1, Pa. Sheraton Hotel, Phila., Pa. December 16, 17, 1960 (following EJCC on Dec. 13-15)

Stan Rogers (Convair-San Diego) will give the keynote, and

Hilliard Page (GE-MSVD General Manager) the welcoming addresses.

Harold Skramstad (NBS) will be Chairman of a session on Equipment and Design,

George Bekey (STL) on Applications,

Dr. Marcel Martin (GE-MSVD) on Programming, and

Joe Pachuta (IBM-Federal Systems Division) on Future Developments.

★ **AIEE-IRE-ACM**
Western Joint Computer Conference

Ambassador Hotel
Los Angeles, California
9-11 May 1961

11th Annual ISA Conference on Instrumentation for the Iron & Steel Industry

Roosevelt Hotel
Pittsburgh, Penna.
March 8-10

10th National Telemetering Conference

Hotel Morrison
Chicago, Ill.
May 22-24

4th International Conference on Bio-Medical Electronics & 14th Conference on Electronic Techniques in Medicine & Biology

Waldorf-Astoria Hotel
New York City, N. Y.
July 9-14

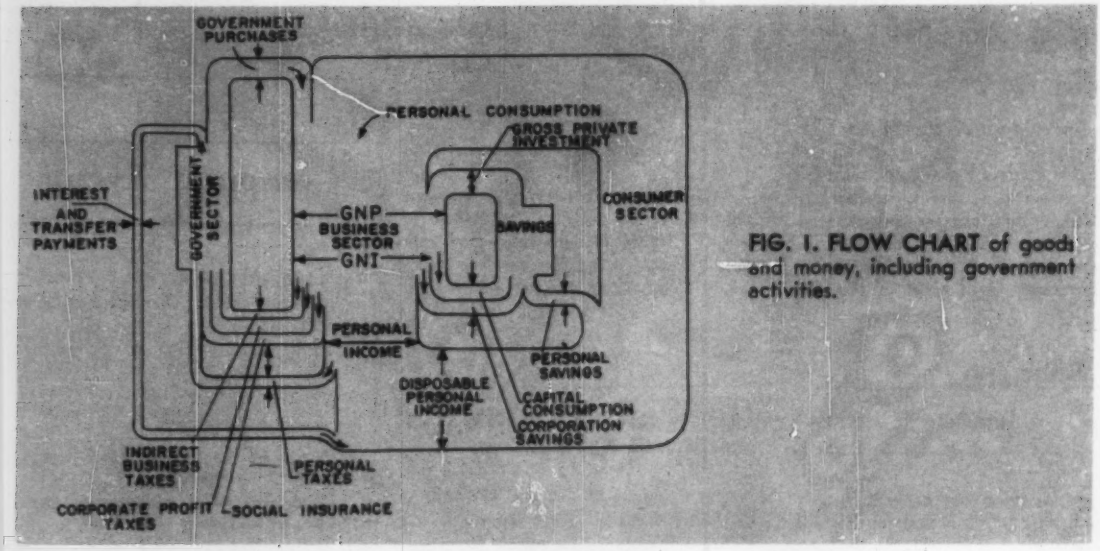

FIG. 1. FLOW CHART of goods and money, including government activities.

SIMULATION OF ECONOMIC SYSTEMS

In this "Age of Computers" it is rather surprising to see that so little is published on the subject of computer applications to economic problems. We seem to be using computers to simulate practically everything, but somehow we neglect the field that affects every human being—economics. Computers are ready and able to help economists. Are the economists ready for this help?

GEORGE S. GLINSKI
University of Ottawa

ECONOMISTS have been building their mathematical "models" of economic reality for the past twenty years. These models are useful only to the extent that they mirror the real world. In other words, the usefulness of a model must be tested by its ability to give quantitative explanation of the past behavior and prediction of the future.

Once constructed, these electronic analogs can be used, first, to provide a convenient means for testing the validity of the assumed relationships in a model. This can be done by comparing the responses of the model with those of the actual economy. Once we thus establish the validity of our model, we can then use it to predict the effect of various parameter changes on the over-all system.

The economist may be interested in either the behavior of "economic atoms," such as individuals or firms, or in the characteristics of large aggregates such as industries, national economy, etc. The models of economic atoms are known as microscopic, and those of large aggregates as macroscopic. In this paper we shall discuss only the latter variety.

Our macroscopic models can be either linear or nonlinear, static or dynamic, and exact or probabilistic (stochastic).

In *linear models* parameters will be constants, independent of the magnitude of the variables. In *nonlinear models* parameters will depend on the magnitude of the variables.

In *static models*, variables will not depend on time. In *dynamic models*, variables will be functions of time.

In *exact models* the magnitudes of the variables will be uniquely defined. In *stochastic models* the

Abstracts from paper in 1958 IRE Canadian Convention Record.

G. S. GLINSKI

George Glinski was born in St. Petersburg, Russia in 1912 and spent his childhood in Finland. He attended the Warsaw Technical University and, in 1937, received his M. Sc. in Electrical Engineering. He continued his post graduate studies towards the Dr. Eng. degree in the field of Applied Physics.

The first three years of World War II he spent in France. Mr. Glinski came to Canada in 1942 and was employed with the Northern Electric Company (in Montreal, and later in Belleville). He is the co-founder of Computing Devices of Canada Ltd., and organized the Data Processing Associates of Canada Ltd. (now the Canadian Electro-Data Division of Burroughs Adding Machines of Canada).

Mr. Glinski has been giving extension and graduate courses in Analog Computers, Digital Computers, Electronic Data Processing and Operations Research at McGill University in Montreal and Carleton University in Ottawa. In 1958 he became the professor of Electrical Engineering at the University of Ottawa where he teaches Communications and Control Engineering. In 1959 he became the chairman of the Electrical Engineering Department of the University of Ottawa.

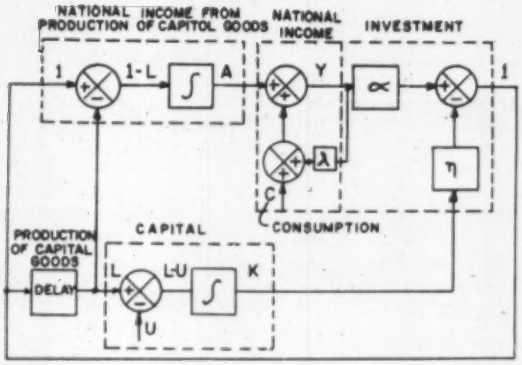

FIG. 2. SIMULATION of linear model of the economic system.

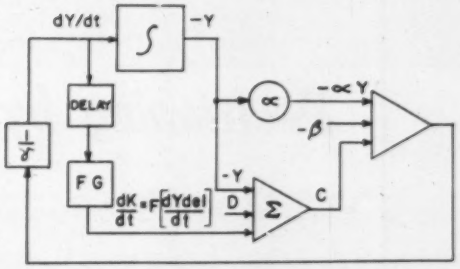

FIG. 3. SIMULATION of nonlinear model of the economic system, proposed by Goodwin[10,12]. It is based on the mechanization of the "consumption function" C, and the national income Y under the assumption of the nonlinear relation between the rate of endogenous investment and past rate of change in national income.

variables will be defined as probability distributions.

One popular way of achieving an economic model is to subdivide our economy into three "sectors"—consumer, business and government. We can then measure the income and spending of each of these three sectors and summarize the results in two tables—Gross National Product (GNP) and Gross National Income (GNI). The GNP includes personal expenditure on goods and services, government expenditure, and gross private investment. The GNI includes personal disposable income, net government income, business income retained.

Fig. 1 represents a flow chart which shows the flow of goods and money, and which includes investments, savings, government, taxes, etc.[5]

Many economists have attempted in the past to build dynamic models of our economy[6]. The main feature of these models is that the investment ceases to be an independent (exogenous) variable and becomes (at least in part) a function of the level of economic activity and its changes. Thus, even the simplest dynamic model must have, in addition to the closed consumption loop, a second closed loop —of investment. Since these two loops are coupled together through the common variable of income, Y, they affect each other and the model must be considered as a whole.

Several attempts to simulate various dynamic models have been made.

As an example of a linear simulator, Fig. 2 shows the block diagram of "modernized" Kalecki's model[8], described by Smith[14]. The capital production block has investment rate I as its input. Its outputs are delayed capital goods and contributions to national income. The delivered capital goods L, less depreciated capital goods U, increase the stock of capital goods. A is added to the part of national income due to production of consumption goods C. This total national income, Y, affects the consumption rate (there is thus feedback from Y to C). The decision to invest (and actual investment I) are affected positively by the level of national income Y and negatively by the total stock of capital goods. This system proved to be unstable and oscillated with a period of 10 years. Moreover it was found that no matter what type of stabilization was introduced (level of taxes, level of permissable investments, government contracts and subsidies, etc.) the "investor" could always counteract these stabilizing affects by selecting proper "strategy."

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Positioning by Magnetostriction

Positioning a slide system accurately often is limited by the stick-slip effect caused by the difference in static and kinetic coefficients of friction. Positioning by a constant-energy device rather than a constant-force device eliminates this difficulty.

ARTHUR PARNES, CHARLES E. WITHAM,
Airborne Instruments Laboratory

HEAVY machine-tool slides positioned by lead screws or other loosely-coupled devices move with a characteristic stop-and-go motion. Once in motion the slide's kinetic energy makes accurate stopping unlikely.

The Inchworm motor obtains its motion from the physical phenomenon known as *magnetostriction*. When certain materials are placed in a magnetic field, they experience a change in dimension. A properly heat-treated nickel rod, for example, can have a magnetostrictive motion of up to 30 microinches per inch of axial length. When a 10"-long nickel rod is saturated in a magnetic field under idealized conditions, the length could change by 300 microinches. The amount of movement obtained is based on (1) the magnetic field strength (up to the point of saturation), and (2) the magnitude of the load being moved.

To translate the magnetostrictive action of the armature into a controlled step, two coaxial clamps (A and B in Fig. 1) are used. Motion to the left is obtained by magnetically expanding the armature while clamp B is locked and clamp A is unlocked. This action moves the left end of the armature to the left. Clamp A is then locked, clamp B is released, and the magnetic field is removed. The removal of the field contracts the armature, which returns to its original size. The right end of the armature has thus moved to the left, and a net motion (step) has been obtained. A reversal of the clamp sequence reverses the motion and a step to the right is produced.

Each clamp consists of a fluid-filled thin-walled ring that contacts the armature. When hydraulic fluid pressure is applied to the clamp, the wall deforms and presses against the armature, forming a friction lock. Removal of the pressure permits the armature to slide freely through the clamp.

A timing motor and cam assembly on the control panel controls the sequence of operation of the step cycle. The automatic step cycle is initiated by a push-button or from a remote signal in closed-loop control systems. The size of the step can be varied by a continuously-variable control on the panel.

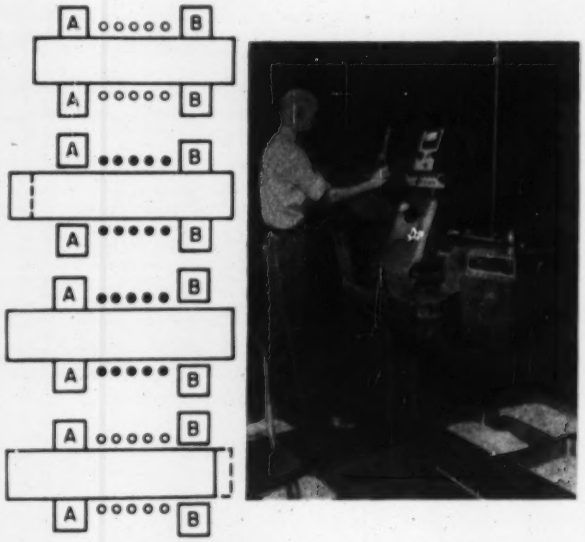

FIG. 1. INCHWORM MOTOR operation. Initially clamps A and B both hold the armature, and the coil between the clamps is not energized. To move left, clamp A is released and current supplied to the coil; the armature expands. Clamp A fixes new position of armature and clamp B is released. Then coil is de-energized and armature contracts. Clamps hold armature in new position.

A magnetic field of about 3" in length, applied to the armature of the Type 202 Inchworm motor with a nickel armature, produces a maximum step size of about 90 microinches. In practice, the step size is about 60 microinches under a 300-lb external load. This is the stick-slip load normally associated with large machine tools, such as centerless grinders.

Abstracts from paper presented at 10th Annual AIEE Machine Tool Conference.

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Model 6702 features simplicity of design and performance. It has replaceable range standards and a plug-in amplifier. Printing and chart speeds are easily changed. Other advantages include the Weston D-PAK (T.M.) which eliminates standard cells, batteries and standardizing mechanisms . . . and a unique printed circuit switch is geared directly to the printing head.

Model 6702 is 39% smaller than the average multi-point recorder, and offers the convenience of rack mounting. It is designed and manufactured with traditional Weston craftsmanship to provide years of dependable, trouble-free service.

Ask your local Weston representative for complete information on this and other Weston instruments for industry, or write for Catalog 08-101-A. Weston Instruments Division, Daystrom, Inc., Newark 12, New Jersey.
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Model 6702 uses full-size chart. Points: 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, or 24. Printing speeds: 3 to 60 seconds per point, readily changed. Operation: 115 volts, 60 cycles or 115 volts, 50 cycles.

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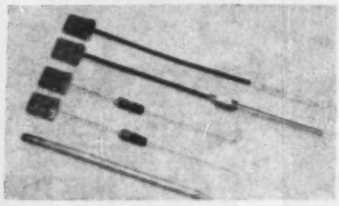
ICS NEW INSTRUMENTS

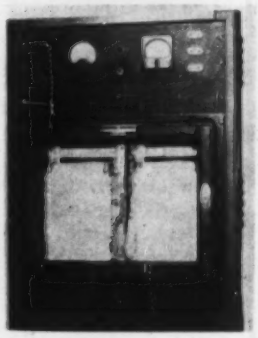
MINI THERMOCOUPLE



New Thrift Therm, miniaturized, fast-response low-priced thermocouple assembly in 4 models, covers the range of thermocouple temperature sensing applications from 0 to 2000°. Kits available in chromel-alumel, iron-constantan, or copper-constantan.—*Dept. TT, Harco Laboratories, Inc., 77 Olive St., New Haven, Conn.*

CIRCLE 177 ON READER-SERVICE CARD

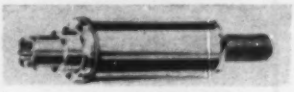
CHART DRIVE



New high-speed chart drive, housed entirely within the recorder case, eliminates the rack modification made necessary by the external drive of an alternate E-A high chart-speed attachment. It provides speeds as high as 3 in/sec.—*Esterline-Angus Co., Box 596, Indianapolis 6, Ind.*

CIRCLE 178 ON READER-SERVICE CARD

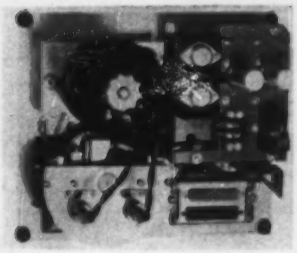
PRESSURE TRANSDUCER



New TP-1000 high capacity pressure transducer with helical Bourdon tube sensing element and single or dual potentiometric outputs performs under severe environments of aircrafts, missiles, and special weapons. It measures gaseous and liquid media from 0-400 to 0-10,000 psi gage or absolute. It is 1.000" diameter, 2" long.—*Fairchild Controls Corp., Components Div., 225 Park Ave., Hicksville, N. Y.*

CIRCLE 179 ON READER-SERVICE CARD

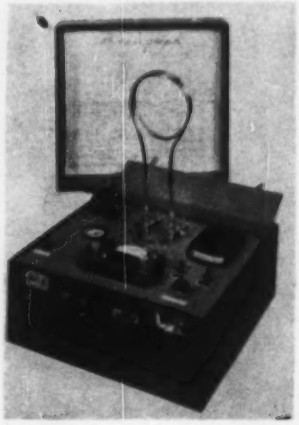
BLOCK READER



New modular Type 290 reader is designed to read simultaneously 8 characters in perforated tape (up to 12 characters on special request) to reduce or eliminate data storage and switching circuits. Applications include check-out and inspection systems, machine tool numerical control systems, and storage system program loading and check-out.—*Ferranti Electric, Inc., 95 Madison Ave., Hempstead, L. I., N. Y.*

CIRCLE 180 ON READER-SERVICE CARD

GAS ANALYZER



New Analograph requires no chemical reagents or training to operate in connection with oxygen, carbon dioxide, and carbon monoxide combustion tests. Combustible gases and vapors may be determined quantitatively in minutes. Continuous sampling of atmospheres is possible and an alarm system can be provided that will warn of either oxygen deficiency or combustible vapors.—*Gas Purifying Materials Co., Inc., 3-15 26th Ave., Long Island City, N. Y.*

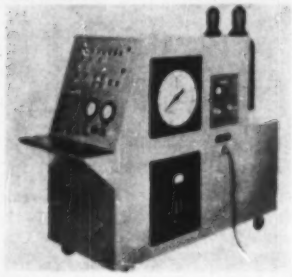
CIRCLE 181 ON READER-SERVICE CARD

PRESSURE TRANSDUCER

New miniature gage pressure transducer Model 304 incorporates a Bourdon tube as the pressure sensing element. Specifications: static error band (includes linearity, friction, hysteresis, resolution and repeatability) as low as ±1.5%; power rating, 0.5 watt at 160°F; operating temperature range, −65° to +212°F. Ranges from 0-100 to 0-5000 psig.—*Bourns, Inc., 6135 Magnolia Ave., Riverside, Calif.*

CIRCLE 182 ON READER-SERVICE CARD

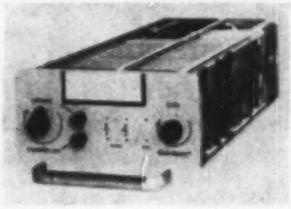
PORTABLE GAS ANALYZER



New portable furnace atmosphere analyzer will accurately monitor trace quantities of oxygen and water vapor in special gas atmospheres. Measurement of as little as 2 ppm of oxygen and 1 ppm of moisture is possible in helium, nitrogen, argon, hydrogen or forming gases.—*Engelhard Industries, Inc., 75 Austin St., Newark 2, N. J.*

CIRCLE 183 ON READER-SERVICE CARD

CALIBRATION SYSTEM



New transducer calibration and conditioning system, Model 1028, provides transducer, excitation, calibration and normalization of the output of virtually any transducer. It eliminates need for duplicate power supplies, voltage references, enclosures and controls.—*Epsco-West, 240 E. Palais Rd., Anaheim, Calif.*

CIRCLE 184 ON READER-SERVICE CARD

The Improved Welch CATHETOMETER

For Precise Measurements

Rapid Leveling—Fine Elevation Adjustment
Graduations Engine Divided for
Uniformity and Accuracy

This latest improved design of the Welch cathetometer possesses a combination of features not hitherto available in an inexpensive instrument. It can be leveled and placed in proper adjustment easily and rapidly, yet all adjustments have sufficient sensitivity and delicacy of control to please the most meticulous user. It is intended for measurements and observations in both industrial and educational laboratories wherever an inexpensive instrument of good precision is needed. It is rigidly constructed and every essential adjustment can be made simply and positively.

No. 68A Each $257.50

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CIRCLE 66 ON READER-SERVICE CARD

DESIGN NOTES on

Control by Rotary Switches

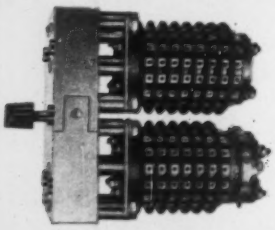
No. 3 of a series

Rotary-switch Applications

One of the simplest applications for a rotary switch is as a single-pole tap switch or a selector switch. In such an application, a single movable contact is connected to one side of the line through a slip ring and, as it is rotated, it engages one stationary contact at a time, thereby selecting the load or circuit to be energized. By leaving certain stationary contacts "dead" or by specifying that they be omitted from the switch in manufacture, provision can be made for "off" positions as required. The form of the movable contact, or in some instances the stationary contacts, can be such as to provide break-before-make (non-shorting) action or it can be made to give make-before-break (shorting) action.

Multi-pole Switching

Double-pole switching is easy to accomplish with rotary switches. It is only necessary to gang two similar single-pole assemblies on a common shaft so that both sides of the line are switched when the handle is turned. Ganging of rotary-switch assemblies is relatively easy in manufacture; in fact one advantage of rotary switches is that there is almost no limit to the number of them that can be mounted in tandem for operation by a single



handle. And when that limit is reached, two, three, or more switches can be gear-driven from a common handle.

Complex Circuit Controls

Probably the greatest advantage offered by rotary switches is their adaptability to complex circuit controls. The rotating blades and the stationary contacts can be made in many different forms. For example: multi-fingered blade assemblies can provide cumulative switching from

ASSEMBLAGE 6

ASSEMBLAGE 11.

a common feed. Assemblage 6 maintains three circuits while adding one and killing another for each position of the handle. Assemblage 11 permits any one circuit to be opened while the other six are kept closed. Other possibilities depend on blade configuration.

ASSEMBLAGE 9

ASSEMBLAGE 4

By ganging blade assemblies on a single rotor, as in Assemblage 9, two independent circuits can be controlled by a single rotary switch, or double-break, double-pole single-throw switching can be accomplished. Assemblage 4 shows a ganged-blade control in which both shorting and non-shorting contacts are combined to suit special circuit requirements.

From these examples, it can be seen that the control possibilities with rotary switches are almost unlimited. Many other examples are shown in Electro Switch Catalog 101-A which lists four-, eight-, and sixteen-position switches in current ratings from 5 to 200 amperes (depending on circuits) and in a wide variety of styles and mountings.

ESCO standard parts or modifications thereof can be combined to suit your special requirements, at standard-switch cost. We welcome your inquiries on special rotary switches, for over 90% of our production is special.

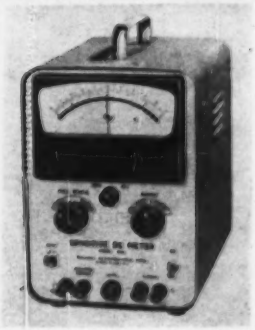
ESCO of WEYMOUTH

ELECTRO SWITCH CORP.

Weymouth (Boston 88), Massachusetts

CIRCLE 67 ON READER-SERVICE CARD

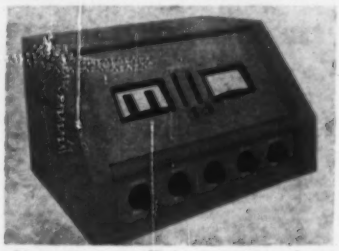
SENSITIVE DC METER



New Model 95A Sensitive DC Meter features 17 voltage ranges (from 10μv to 1000v) and 25 current ranges from 1$\mu\mu$a to 1 amp. Accuracy is 3% of full scale on all but the most sensitive voltage and current ranges.—*Boonton Electronics Corp., 738 Speedwell Ave., Morris Plains, N. J.*

CIRCLE 185 ON READER-SERVICE CARD

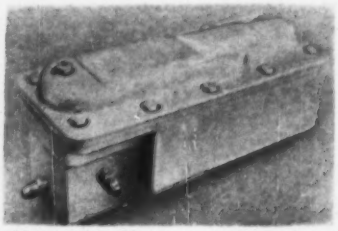
GAS ANALYZER-MONITOR



New Therma Bridge gas analyzer-monitor for continuously scanning atmospheres surrounding the loading and storing operations of missile fuels can be calibrated to measure hazardous concentrations down to 0-10 ppm Unsymmetrical-dimethyl hydramine (UDMH) or 0-100 ppm Nitrogen Tetroxide in air full scale.—*Industrial Instruments Engineering Corp., 89 Commerce Rd., Cedar Grove, N. J.*

CIRCLE 186 ON READER-SERVICE CARD

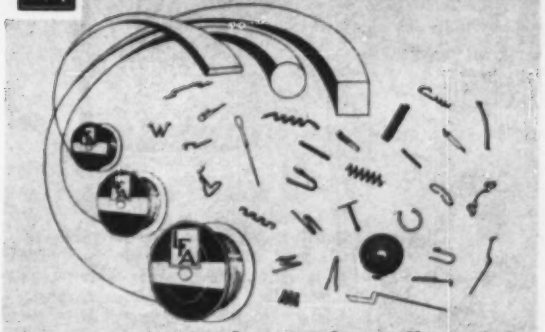
ELECTRO-PNEUMATIC CONVERTER



New PowrMag converter accepts electrical input signals of 1-9 v or milliamps dc, or 1-5 v or milliamps dc. Pneumatic output signal ranges are 0-30, 0-15, 3-27, 3-15 psi, or the inverse of these ranges. Instrument is statically and dynamically balanced for resistance to shock and vibration. Bulletin MYP 722A.—*Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa.*

CIRCLE 187 ON READER-SERVICE CARD

. . . . ROUND, SQUARE AND FLAT SPECIAL ALLOY WIRE



. . . . . is Used to Make Millions of Tiny Forms and Springs for Industry.

Modern production applications (printed circuit, spring, connectors, terminals, tabs) require all types, shapes and finishes (solder dipped and plated, etc.) of special alloy wire for production of miniature and sub-miniature formed parts.

These new production techniques reduce costs, more importantly, are a guarantee of better quality control, positive size holding and minimizing finish problems.

BERYLLIUM COPPER Silvercote ® | ni-clad-ti | titanium | ALUMINUM | phosphor bronze | Hot Solder Dipped | Tinned

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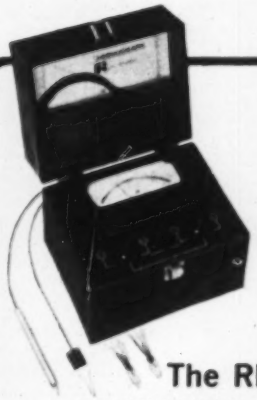
CIRCLE 68 ON READER-SERVICE CARD



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THERMAL TEST SET

A compact, portable unit for obtaining temperature measurements in electronic equipment — from the individual component to the package itself. Applications include: transistors, diodes, tubes, transformers, micro-miniature circuits, etc.

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Select from over 3,500 different SOLENOID VALVES from VALCOR

Series SV-54 (3 way-4 way) general purpose solenoid valves for air, oil and water. Rugged construction, yet inexpensive. Multi-million cycle life. Pressure ratings up to 150 psi. Nylon seat outlasts steel. Infinite varieties available. Lists as low as $10.75.

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Series SV-5100 Specifically designed to handle the most corrosive media in industry. Manufactured in Teflon, PVC and Nylon varieties. Diaphragm construction prevents media contact with any metal. Available in direct-acting or piloted models.

VALCOR SOLENOID VALVES

FREE...new 16 page brochure —lists over 500 corrosive media—coded for correct valve selection.

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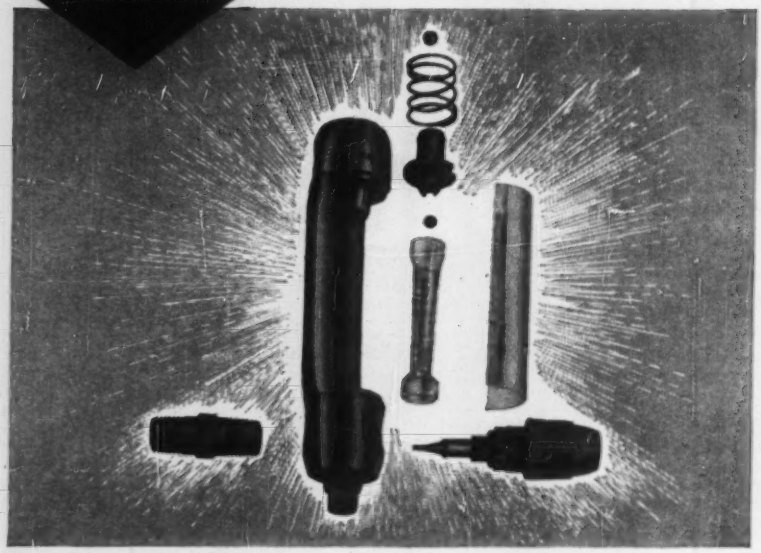
CIRCLE 70 ON READER-SERVICE CARD

NOW *fresh design approach gives* THE PURGE METER YOU INSTALL AND FORGET*



It's the new Wallace & Tiernan Varea-meter designed for long, maintenance-free life. Install it and relax . . . forget maintenance headaches.

The Varea-meter's all-stainless, unitized frame shrugs off pipe strains, resists corrosion. There are no small screws or bolts to "freeze"; "O"-rings give permanent, leak-tight sealing. And the Varea-meter's stainless spring really lasts. It's positioned outside the flow stream . . . locks the tube in place externally.

For truer flow indication, a new high-stability float assures foolproof measurement. And for extra convenience, control valve may be placed at the inlet or outlet.

For economy, W&T Varea-meters convert for increased or changed flows with the meter right in the line. And 90% of all parts are interchangeable whether the scale length is 1½" or 3".

There are 29 tube capacities for both scales. Maximum flows for both are 40 gph of water, 110 scfh of air.

Full details and easy-to-order form are ready now. Write Dept. V-1.48.

WALLACE & TIERNAN INCORPORATED

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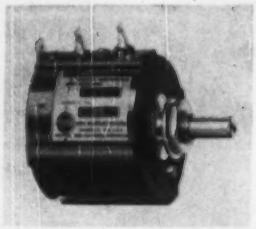
CIRCLE 71 ON READER-SERVICE CARD

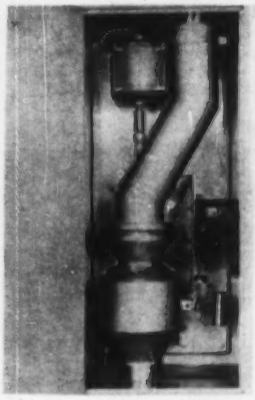
HIGH-QUALITY POT



New Model 205-3T (three-turn) Micropot offers a major reduction of housing length which is only $1\frac{31}{64}$". Claimed to be the most rugged and reliable precision potentiometer commercially available.—*Borg Equipment Div., Amphenol-Borg Electronics Corp., 120 South Main St., Janesville, Wis.*

CIRCLE 188 ON READER-SERVICE CARD

DRY-FLOW METER



New precision IPI dry-flow meter provides continuous, instantaneous or recallable stream-flow data and a low-cost approach to automation of dry-flow bulk processes. Gives direct readings in unit weight per unit time, makes permanent recordings of flow, or totalizes readings for any time period.—*Industrial Processes, Inc., 621 S. W. Morrison St., Portland 5, Oregon.*

CIRCLE 189 ON READER-SERVICE CARD

ELAPSED TIME INDICATOR

New miniature Elapsed Time Indicator, Model 1440, is a decimal-type counter with unusually large characters for easy readout. Provides readings from 0000 to 9999 hours with return to 0000. Input requirement is 115 v/400 cps single phase.—*Bowmar Instrument Corp., 8000 Bluffton Rd., Ft. Wayne, Ind.*

CIRCLE 190 ON READER-SERVICE CARD

OUR 32nd YEAR

"PYROMETEERS"

INDUSTRIAL PYROMETER AND SUPPLY Co ALTON ILL U.S.A.

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BIG PARTY ★ SHERATON JEFFERSON HOTEL

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Wednesday, Jan. 18, 9:00 p.m. till 2:00 a.m.

★ See Our Gigantic Floor Show

★ Big Bar—All the Finest Liquors you can drink.

★ 10 pc. Orchestra—Dancing ★ Beautiful Girls—Side Attractions

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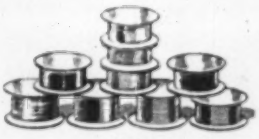
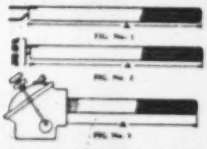
INDUSTRIAL PYROMETER & SUPPLY CO. ALTON, ILL. U.S.A.

WORLD'S OLDEST ACTUAL MANUFACTURER OF PYROMETER & THERMOCOUPLE EXTENSION LEAD WIRE.



WIRES



THERMOCOUPLES

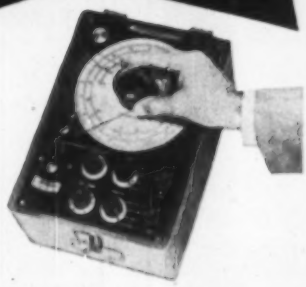
THERMOCOUPLE LEAD WIRES

Avery Hack

CIRCLE 61 ON READER-SERVICE CARD

MODEL 9B PYROTEST

The Most Versatile Portable Potentiometer Made



- **Checks any thermocouple-actuated instrument**
- **Guaranteed accuracy— ¼ of 1%.**
- **9 interchangeable, direct-reading scales**

Pyrotest is the only portable potentiometer that can check any thermocouple-actuated indicator, controller, or recorder. It comes with 6 thermocouple scales and 3 MV scales—as easy to change as phonograph records. Scale length of over 4 feet, with high resolution to match. Pyrotest is so accurate, it's used as a standard in the lab . . . so versatile and rugged, it's used as an all-purpose tool everywhere in the plant. Only $315.00, fob Indianapolis. Write for free Bulletin 9-B.

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CIRCLE 62 ON READER-SERVICE CARD

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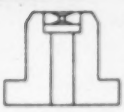
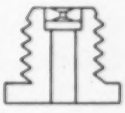
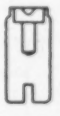
for AIRCRAFT • ELECTRICAL MECHANICAL and MARINE INSTRUMENTS







Sapphires set in brass, or other metal assemblies made in any quantity to close tolerance specifications are produced by Moser Jewel Company—*manufacturers of industrial jewels for over 50 years.*

Moser also provides highly polished pivots, staffs —silicon and spring loaded assemblies for high shock resistance.

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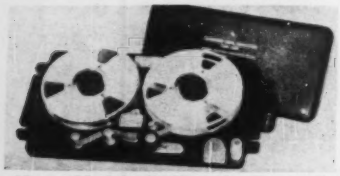
"Manufacturers of all types of Industrial Jewels"

CIRCLE 63 ON READER-SERVICE CARD

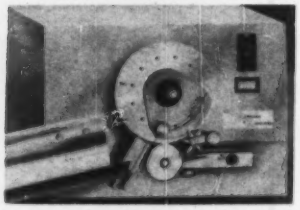
MINIATURE TAPE RECORDER



New Model PMR-300 Tape Recorder features wideband multi-channel recording under rugged environmental conditions. Recording bandwidth extended to 100 kc at 30 ips.—*Pacific Electro Magnetics Co.*, 942 *Commercial St., Palo Alto, Calif.*

CIRCLE 191 ON READER-SERVICE CARD

AUTOMATIC WIRE CUTTER



New Automatic Wire Cutter, Model CWA-300, for production applications. Wire lengths from 1" to 60" can easily be produced in production quantities on this cutter. All types of bare and insulated wire and sizes from 26 to 12 gage can be handled.—*Dickinson & Associates*, 940 *Alma St., Glendale 2, Calif.*

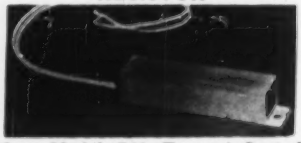
CIRCLE 192 ON READER-SERVICE CARD

ULTRASONIC CLEANER

New ultrasonic Cleaning Equipment consists of a Sonogen tank/transducer combination, Type T-32, and a Model AP-10 generator which transforms conventional 110-v a-c current into high-frequency (40-kc) oscillations.—*Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn.*

CIRCLE 193 ON READER-SERVICE CARD

TEMP COMPENSATION RESISTOR



New Model 760 Temp-A-Just Resistor can be adjusted externally without affecting the fixed resistance value. Specifications include: temperature coefficient adjustment range from 10 ppm/°C to 4500 ppm/°C, resistance tolerance 1% at 25°C and power rating 1 w.—*Conrad-Carson, Inc.*, 3110 *Goddard Way, San Diego, Calif.*

CIRCLE 194 ON READER-SERVICE CARD

PRESSURE TRANSMITTER

New Compu-Tran explosion-proof low pressure transmitter is designed for use in explosive and corrosive atmospheres. Zero and range adjustments are external to the explosion-proof case and can be made without breaking the seal. It is manufactured in 6 models with standard ranges from 0-1½ to 0-60 psi differential, gage or absolute. Resolution is infinite and measurement accuracies to ±0.15% of range are available.—*Control Components Div., International Resistance Co.*, 401 *N. Broad St., Phila. 8, Pa.*

CIRCLE 195 ON READER-SERVICE CARD

ARCCO CANNON
NEVER-DRY PEN
Writes for Months
REPLACES OTHER MAKES • USES REGULAR INKS
Regardless of pulsations or other causes of ink failures this Never-Dry Pen will make clean and complete records.
CHECK THESE EIGHT FEATURES
1. Always a continuous flow. No unrecorded records.
2. Holds sufficient ink for several months recording.
3. Constant weight for more accurate measurement.
4. Always clean, uniform records due to uniform flow.
5. No ink slopping or dripping in meter cases or on floor.
6. Uses regular recording inks or fast drying inks.
7. Stainless steel assures long and trouble-free service.
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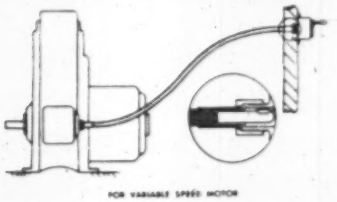
CIRCLE 74 ON READER-SERVICE CARD

VIBRATION CALIBRATOR

New portable self-contained vibration exciter for field calibration of vibration pickups permits on-the-spot checking of vibration and pressure transducers without use of complex test equipment. Provides accurate excitation frequency and uses a minimum of energizing power due to elimination of electronic exciters. Visual amplitude indicator reads absolute measurement of vibration displacement.—*Gulton Industries, Inc.*, 212 *Durham Ave., Metuchen, N. J.*

CIRCLE 344 ON READER-SERVICE CARD

FLEXIBLE SHAFT ASSEMBLIES



FOR VARIABLE SPEED MOTOR

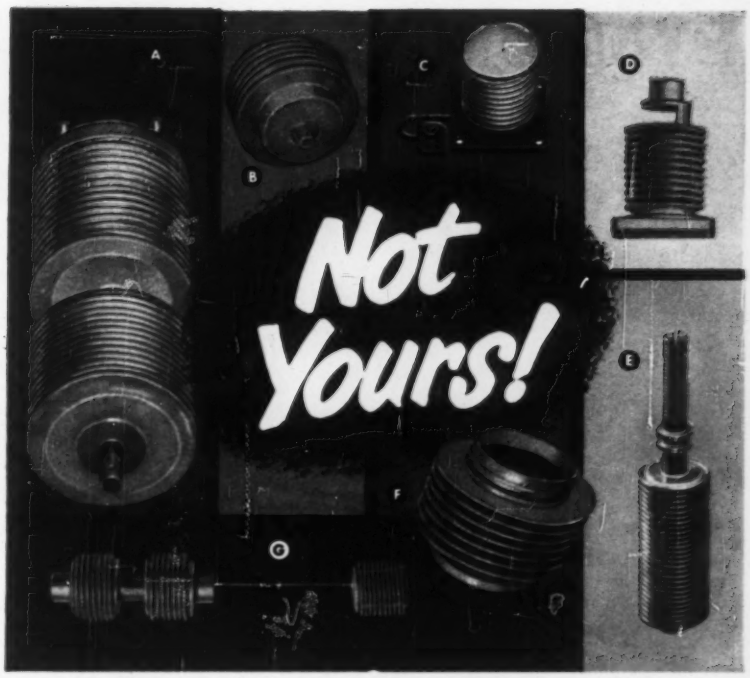
New Circle Ess standard flexible shaft assembly is offered in 4 different cable sizes 0.130", 0.150", 0.187", 0.250", as standard flexible shaft for industrial use and as standard panel mounted flexible shaft with mounting nuts as part of shaft itself.—*F. W. Stewart Corp.*, 4311-13 *N. Ravenswood Ave., Chicago* 13, *Ill.*

CIRCLE 345 ON READER-SERVICE CARD

VACUUM GAGE

New portable thermocouple vacuum gage can be operated for up to 60 hours on its 1.3-v nickel-cadmium-cell battery, or can be plugged into any 120v ac outlet. Is calibrated from 1 to 1000 microns.—*General Electric Co., Schenectady* 5, *N. Y.*

CIRCLE 346 ON READER-SERVICE CARD



If you're a bellows user, odds are high against one of these being yours; they're merely typical of the thousands of different types we've produced for almost every branch of industry.

Name your conditions of stress, atmosphere, temperature, vibration, pressure . . . tell us the flexibility, sensitivity, durability you need.

Backed by the most experienced know-how in the field, every Robertshaw Bellows is custom-engineered to do a particular job . . . and do it more efficiently, more economically.

Get the full story on Robertshaw Bellows and Bellows Assemblies . . . and some good, solid bellows background . . . in Catalog XL-R. FULTON SYLPHON DIVISION, ROBERTSHAW-FULTON CONTROLS CO., KNOXVILLE 1, TENNESSEE.

A. Brass aneroid assembly, ambient pressure compensation. Large bellows for added power and sensitivity.

B. Beryllium copper aneroid assembly for aircraft pressure controls. Highly flexible, durable, sensitive. Silver-brazed construction.

C. Pressure sensitive brass bellows with special end fittings.

D. Brass thin-walled bellows for extreme sensitivity and flexibility.

E. Liquid filled thermostatic assembly; pressure insensitive.

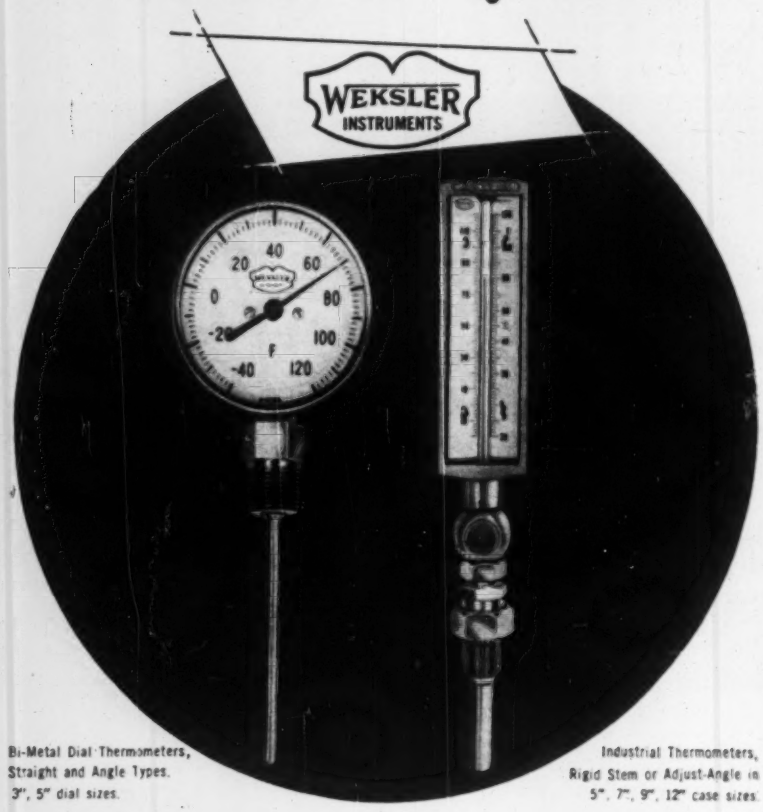
F. Seamless, stainless steel bellows; welding ends. For vibration isolation or misalignment; accommodates pipe movement on sealed systems.

G. Highly flexible brass bellows for aircraft; compensated for ambient pressure changes for absolute pressure response.

Robertshaw MR. CONTROLS

CIRCLE 76 ON READER-SERVICE CARD

SYMBOL OF QUALITY



Bi-Metal Dial Thermometers, Straight and Angle Types. 3", 5" dial sizes.

Industrial Thermometers, Rigid Stem or Adjust-Angle in 5", 7", 9", 12" case sizes.

in Liquid-In-Glass Industrial and Bi-Metal Thermometers

Indicating and recording instruments for temperature, pressure and humidity. *This is our one and only business.*

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To design, engineer, produce and deliver the most complete and finest line of instruments in our field of specialization that you'll find . . . *anywhere!*

The Weksler Specification Bulletin covers indicating and recording pressure gauges, industrial thermometers, dial thermometers, recording thermometers, recording hygrometers, bi-metal, thermometers, laboratory thermometers and hydrometers. *Write for your copy.*

"ORIGINATORS OF WORLD RENOWNED ADJUST-ANGLE THERMOMETERS"

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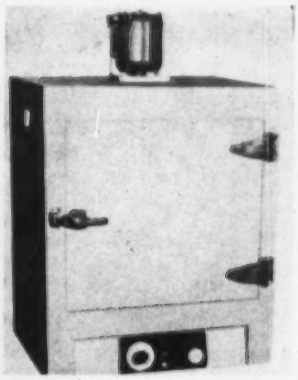
WEKSLER INSTRUMENTS CORP.

195 EAST MERRICK ROAD, FREEPORT, L. I., N. Y.

Indicating and Recording Instruments for Temperature, Pressure and Humidity

CIRCLE 77 ON READER-SERVICE CARD

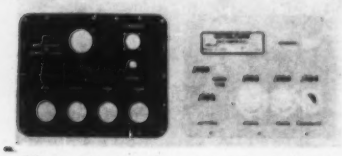
LABORATORY OVEN



New Laboratory Oven, Model VU-5-33, utilizes forced convection, and provides automatic control over a three-heat range up to 500°F max. Only 20" x 16" x 18" in size, it is shipped completely wired and ready for operation.—*Despatch Oven Co., 619 SE Eighth St., Minneapolis, Minn.*

CIRCLE 196 ON READER-SERVICE CARD

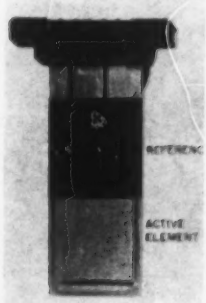
CUSTOM INSTRUMENT PANELS



New standard or custom Instrument Panels, including their fabrication, painting, finishing, engraving and silk screening, also to MIL specifications, are now available.—*Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.*

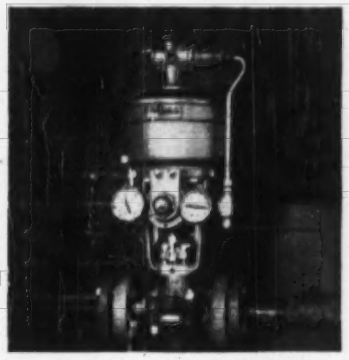
CIRCLE 197 ON READER-SERVICE CARD

ELECTRIC RESISTANCE PROBE



New type of Electrical Resistance Probe senses with extreme sensitivity environmental changes such as caused by hard-to-detect liquid and gaseous contaminants, changes in humidity, ozone concentration, water content in a non-aqueous liquid, or other environmental conditions which have a tendency to attack metal.—*Crest Instrument Co., Div. of Magna Products, Inc., 11808 S. Bloomfield Ave., Santa Fe Springs, Calif.*

CIRCLE 198 ON READER-SERVICE CARD



"Best valves we ever found for tight shutoff on our maleic acid lines" says Instrument Foreman of a well-known mid-west chemical plant.

YOU CAN COUNT ON

CONOFLOW LB CONTROL VALVES

FOR TIGHT SHUTOFF

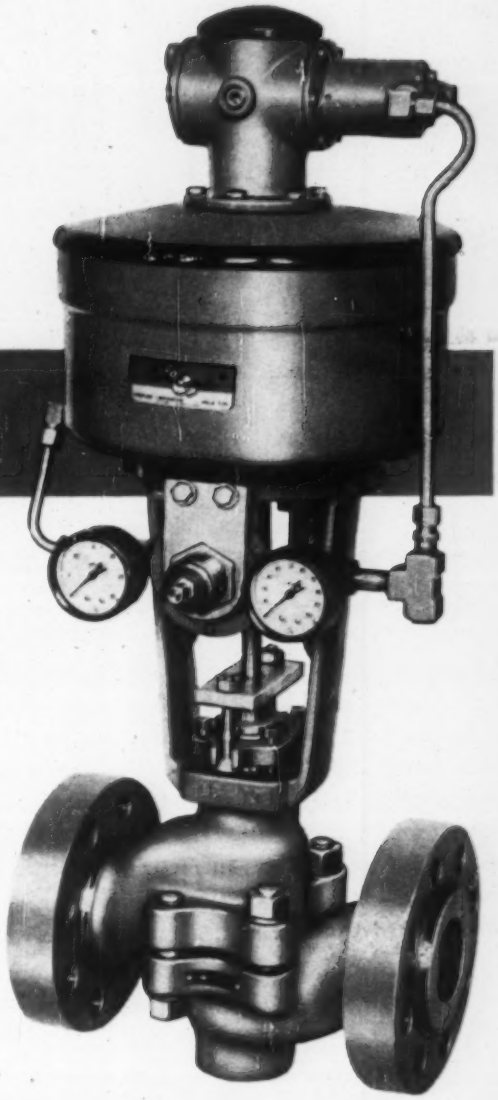
Major chemical companies have switched to Conoflow Series LB Control Valves because they provide absolute tight shutoff, regardless of operating variables. Tight shutoff prevents waste of costly liquids and gases . . . insures precise process control.

The answer is the single-seated body and the powerful cylinder actuator of the LB Valve. This integrated body-actuator design allows for leak-proof shutoff not possible with double-seated valves.

An added feature of the LB Valve is much lower all-around maintenance costs. Body separates easily at seat ring for tear down and inspection. Fewer replacement parts mean substantial inventory savings. Streamlined body contours and extra thick walls assure longer life in corrosive and erosive services. Also, when it comes to special alloys . . . type 316 Stainless steel, Hastelloys, Monel, Nickel, Everdur, etc., the single-seated LB Valve offers a substantial initial cost advantage over double-seated construction. By all standards, your overall cost is much less for a Conoflow Series LB Valve.

Also available with sturdy handwheel actuators for precise manual control.

If you are not already a user, try a Conoflow LB Control Valve . . . and let it prove itself.



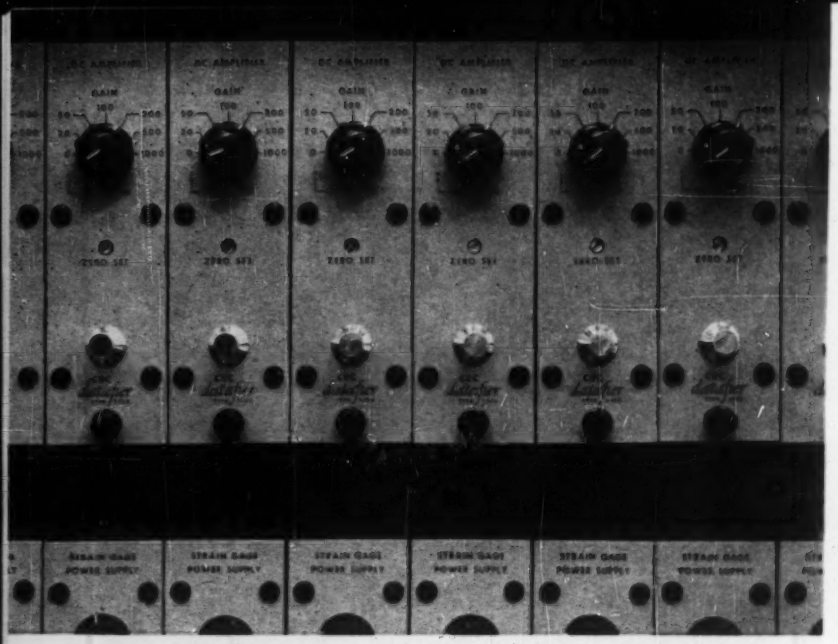
Phone your nearest Conoflow representative (located in principal cities), or write to Conoflow Corporation, 2100 Arch Street, Philadelphia 3, Pa. for Bulletin LB-3-I.

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

SUBSIDIARY WALWORTH

CIRCLE 78 ON READER-SERVICE CARD

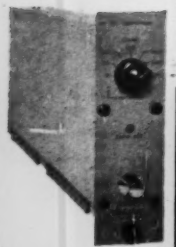


TOP PERFORMANCE IN THE TOP ROW . . .

NEW FROM CEC . . . a wide-band d-c amplifier for handling low-level signals from d-c to 10 kc. Use the new 1-155 to get the full bandwidth capabilities from your recording oscillograph galvanometers. "Driven shield" techniques assure you of the highest common mode rejection characteristics and permit new flexibility in system applications. Circuitry is all solid state with internal, fully regulated power supply and complete isolation from line variations.

Specifications:

Frequency response	D-C to 5 kc, ±1%, d-c to 10 kc, ±3%
Output	200 ma peak to peak, 20 volts peak to peak
Input voltage	10 mv peak for full-scale output
Input impedance	250,000 ohms in parallel with 100 μμfd
Output impedance	Less than 0.04 ohms
Drift	±2 microvolts max. in 200-hour period measured from start-up time
Common mode rejection	140 db at 60 cps; 120 db d-c to 1500 cps
Noise	Less than 8 μv rms 20 cps to 10 kc Less than 3 μv P-P 0 to 20 cps
Rise Time	10 microseconds
Operating voltage and power	95-135 volts, 50 to 400 cps, 10 watts, maximum
Type of circuitry	All solid-state electronics with internal regulated power supply



For complete information, write for Bulletin CEC 1155-X4

Individual channels of the 1-155 D-C Amplifiers are completely self-contained and designed for plug-in mounting. RETMA rack holds eight units across. Enclosures for single units are also available.

Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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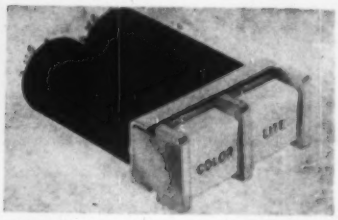
T-FITTING

New Tylok 4-Seal T-Fitting, which gives the benefits of a single-piece installation, embodies four positive seals against pressure, temperature, vibration, surge, plus a vibration dampener. Offered in size range from ⅛" through 2" dia with pipe thread. —*C. B. Crawford Co., 16606 Waterloo Rd., Cleveland 10, Ohio.*

CIRCLE 199 ON READER-SERVICE CARD

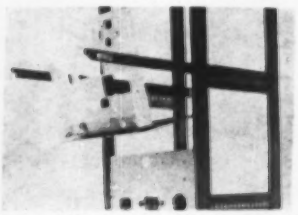
PUSH BUTTON SWITCH



New Push Button Lit-Switch (lighted push button switch), Model 801, for dry circuit to 3-amp operation is available single pole to six poles, DT or ST.—*Color-Lite Div., Sloan Co., 7704 San Fernando Rd., Sun Valley, Calif.*

CIRCLE 200 ON READER-SERVICE CARD

INSTRUMENT SLIDES



New solid-bearing 100-and 200-pound-capacity Slides feature simplified functional design. This design provides for variations in length, mounting, tilt or non-tilt, plus positive extended locking. Slides meet Mil. spec.—*Christman Industries, 1562-61st St., Brooklyn 19, N. Y.*

CIRCLE 201 ON READER-SERVICE CARD

CABLE CLAMPS

New 660 Series Cable Clamps molded of tough polypropylene have heat resistance approaching that of nylon, improved chemical resistance, and are virtually unbreakable. Sizes from ⅛" to ½" are in stock.—*Commercial Plastics Co., 945 George St., Chicago 14, Ill.*

CIRCLE 202 ON READER-SERVICE CARD

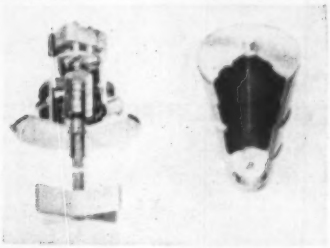
←CIRCLE 79 ON READER-SERVICE CARD

PLASTIC PIPE CAPS

New 600 Series Closure Caps made of tough, durable polyethylene and NEMA color coded, feature a single internal thread; hereby they are easily applied. Sizes range from ⅛" to 2" nominal pipe and conduit size. —*Clover Industries, Inc.*, 578 *Young St., Tonawanda, N. Y.*

CIRCLE 203 ON READER-SERVICE CARD

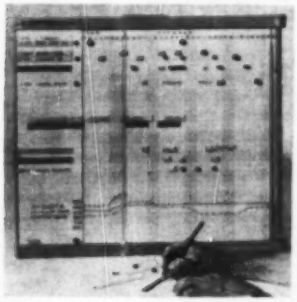
BIN-VUE LEVEL INDICATORS



Two new Flexi-Shaft Bin-Vue Level Indicators include a 1/100-hp motor which turns a 4-blade paddle by means of a torsion spring. The paddle turns continuously as long as no material touches it. If material makes contact with the paddle, it stops. However, the motor continues to run, expanding the spring until it actuates a limit switch.—*Convair*, 1059 *Bayridge Ave., Pittsburgh* 26, *Pa.*

CIRCLE 204 ON READER-SERVICE CARD

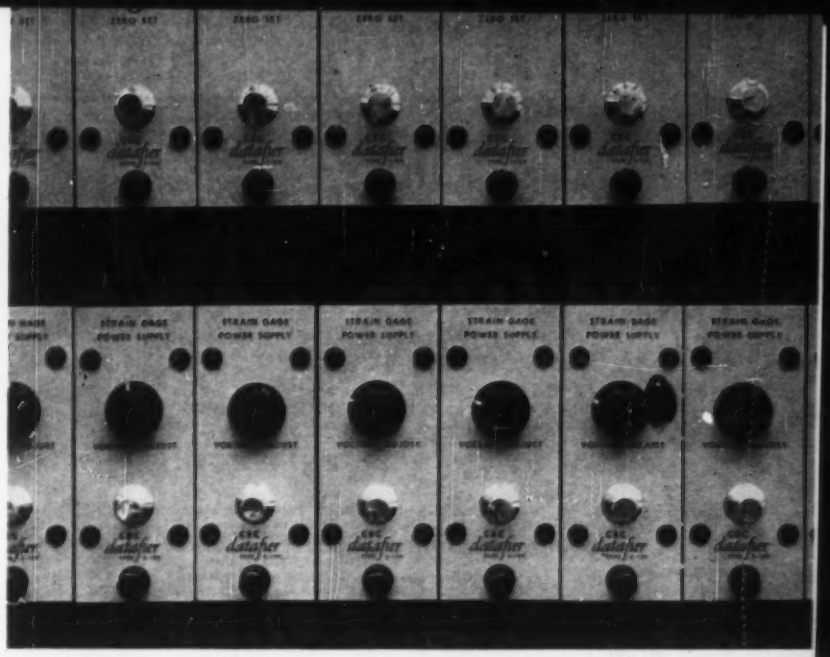
VISUAL CONTROL BOARD



New Rol-a-chart Magnetic, a Visual Control Board has magnetic indicators which move with a sleeve as it is turned, and thus are brought closer and closer to the line that marks "today." Board is built of steel and finished in gray hammar tone. Bulletin gives details.—*Conley, Baltzer & Steward, Rol-a-chart Div.*, 494 *Jefferson St., San Francisco* 9, *Calif.*

CIRCLE 205 ON READER-SERVICE CARD

CIRCLE 80 ON READER-SERVICE CARD →



OUTSTANDING PERFORMANCE IN THE BOTTOM ROW, TOO . . .

NEW FROM CEC . . . 3-139 Strain Gage Power Supply – a highly stable, regulated excitation voltage source for strain gage transducers. The Power Supply circuit features complete isolation from the a-c line for the highest system common mode rejection. Perfect for use in any strain measurement system, the 3-139 provides an ideal companion for the 1-155 D-C Amplifier because of their common driven shield circuitry.

Specifications:

Output voltage	2 to 15 volts, continuously variable
Output current	0 to 200 ma
Regulation	±0.05% for 10% line changes from 95 to 135 volts
Ripple	0.5 mv P-P for all load and output conditions
Output impedance	Less than 0.04 ohms
Power line noise current to ground	0.25 microamperes, rms, max.
Operating voltage	95-135 volts a-c, 50 to 400 cps

For complete information, write for Bulletin CEC 3139-X3

Type 3-139 Strain Gage Power Supplies are shown with a CEC 5-123 Recording Oscillograph. A standard RETMA rack holds eight of the units on a 5¼"-high panel.

Electro Mechanical Instrument Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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- PRIMARY PRESSURE STANDARD
- mercurial BAROMETERS
- precision MANOMETERS
- PRESSURE CONTROLLERS

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√ MICROMETER STANDARD BAROMETER
Type MS-2, Primary Pressure Standard, Accuracy .001" RMS
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√ BAROMETERS AND MANOMETERS,
Type A-1, Precision Mercurial, Temperature and Gravity Compensation
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√ PHOTO SCANNER, Type PSR-1
Micro Reading (.0001"), pressure deviation signal, Accessory for Type A-1 Barometers and Manometers

√ PRESSURE CONTROLLER, Type PSC-2
Servo + Manual operation for automatic setting and holding pressures to within +.0005" Hg.

√ PRESSURE CONTROLLER, Type MPC-2
Manual operation for manual setting and holding pressures to within +.001" Hg.

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CIRCLE 81 ON READER-SERVICE CARD

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100 ELECTRONIC CIRCUITS

A continuation of the well-received Volume 1, this later edition covers new ground including circuits for power supplies, oscillators, instruments, amplifiers, phototube and pulse applications. Also gives complete data on telemeters, controllers and alarms. Paper, 212 pages, 1960. Price only $2 per copy.

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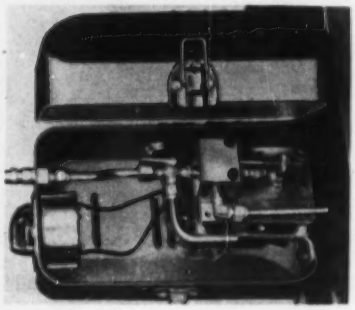
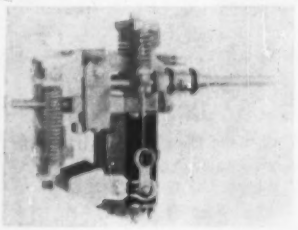
MOTOR-DRIVEN PUMP



New Positive Displacement motor-driven Pump can move as little as one drop of liquid every 5 min or as much as one pint/min, and is available with an electronic timer which makes its performance completely fool-proof.—*Bomar Labs. Ltd., Pump Div., Sheridan Rd., Winona, Chicago 41, Ill.*

CIRCLE 206 ON READER-SERVICE CARD

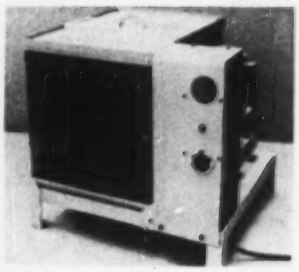
LINEAR SENSING BELLOWS



New welded diaphragm Bellows Assemblies are for operating pressures of 250 psi and pressures to 5000 psi can be withstood without deformation.—*Breeze Corp., Inc., 700 Liberty Ave., Union, N. J.*

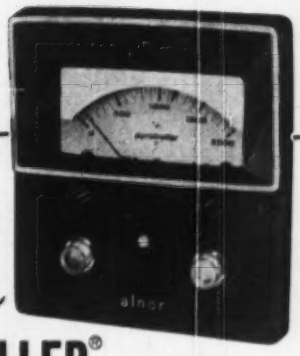
CIRCLE 207 ON READER-SERVICE CARD

PRINTED CIRCUIT ETCHER



New table Model Oscillating Spray Nozzle Etcher for proto-type printed circuit work features polyvinyl-chloride-and-titanium construction throughout. Uses ferric chloride or chromic acid to etch both sides simultaneously on boards up to 10¾". Line widths obtainable to 0.003".—*Centre Circuits, Inc., Box 165, State College, Penna.*

CIRCLE 208 ON READER-SERVICE CARD



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An electronic temperature controlling instrument that automatically controls the heat source to maintain a constant temperature within a set range.

Designed for temperature control on heat treating furnaces, ovens, heat sealing equipment, plastic moulding machines, cooking vessels, or any application where a precise uniform temperature must be maintained.

Various temperature ranges, −100° F. up to 3000° F. can be supplied to meet your requirements. Our engineering service is available for special applications.

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Alnor INSTRUMENTS

ALNOR INSTRUMENT CO.
Division of
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CIRCLE 82 ON READER-SERVICE CARD

CAMBRIDGE Moisture Indicators

Cambridge Moisture Indicators are accurate, rugged instruments built for continuous shop service to indicate moisture content of various hygroscopic materials. Insertion model has measuring element enclosed in a blade. Surface model has the element mounted on under side for surface contact. Adjustable pointer is provided for fixing reference points of surrounding air.

Surface Model

Insertion Model

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CIRCLE 83 ON READER-SERVICE CARD

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SPECIFICATIONS

Freq. Range	20 cps to 27 k cps
Dimensions	Diameter 6" Height 8½"
Force Factor	5 lbs/amp
Moving Weight	¼ lb
Max. Displ.	⅜ DA inches
Nominal Force Output	20 lbs
Platform Mounting (other mountings on order)	¼X28 stud
Voice Coil Impedance	10 ohms
Total Weight	45 lbs

NOTE: The frequency response with a 2oz load is flat to within 10%, from 50 c/s to 10 kc/s with NO feedback

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CIRCLE 84 ON READER-SERVICE CARD

PALMER

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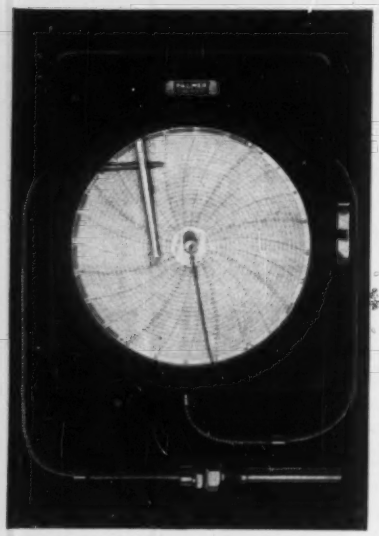

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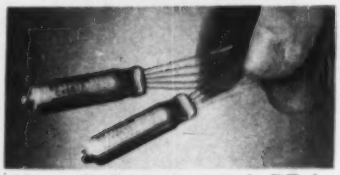
Cincinnati 12, Ohio

CIRCLE 85 ON READER-SERVICE CARD

IGS NEW INSTRUMENTS

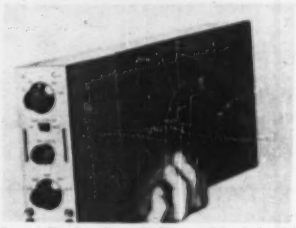
RF AMPLIFIER TUBES



New subminiature pentode RF Amplifier Tubes, the CK6611 with a mutual conductance of 1000 micro-mhos at a filament power of only 25 mw, and the CK6612 with a mutual conductance of 3000 micro-mhos at a filament power of only 100 mw, have a maximum d-c plate voltage of 30.—*Industrial Components Div., Raytheon Co., 55 Chapel St., Newton, Mass.*

CIRCLE 209 ON READER-SERVICE CARD

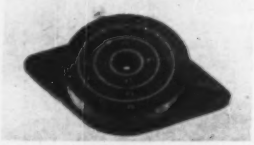
D-C AMPLIFIER



New D-C Amplifier, Model 1100, combines the features of three individual units in one package: a differential-input wideband d-c amplifier, a bridge-balance circuit, and a well regulated strain-gage power supply. It eliminates the hookup problems formerly encountered in multiple-strain-gage operations.—*Cubic Corp. 5575 Kearny Villa Rd., San Diego 11, Calif.*

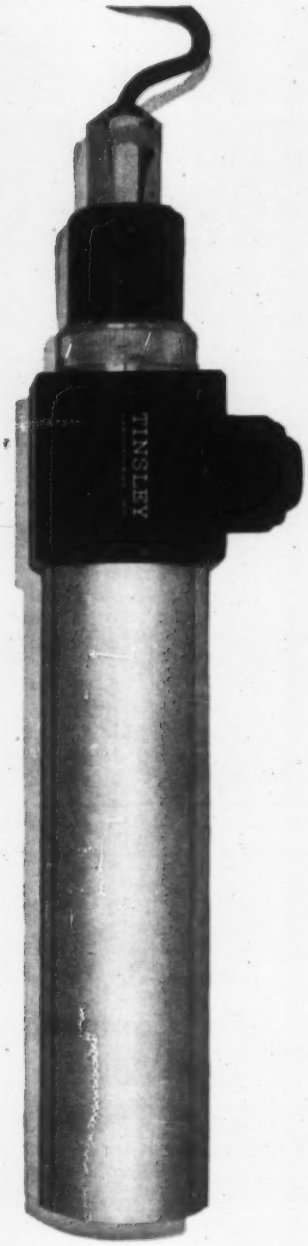
CIRCLE 210 ON READER-SERVICE CARD

ROTARY TABLE



New 4-inch Rotary Table has a ⅝"-24 threaded center hole with ⅝" counterbore and twelve #10-32 tapped holes for securing work-holding devices. Top surface has concentric circles machined on 1", 2" and 3" diameters to aid in the location of work pieces. Rotates through 360° and has an accurately graduated scale with direct readings to one degree and to one minute with the vernier.—*Mico Instrument Co., 80 Trowbridge St., Cambridge, Mass.*

CIRCLE 211 ON READER-SERVICE CARD

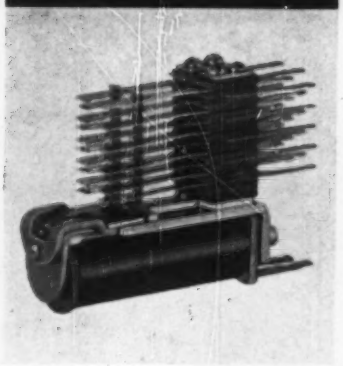


Why pay for an expensive alignment telescope when a Tinsley Autocollimator may meet your requirements for hundreds of dollars less? The Tinsley Autocollimator is easily capable of reading precise angles to ¼ minute accuracy. 20 power. Interchangeable light source and eyepiece for viewing from end or side. Fits standard fixtures. Economical and dependably accurate. Write for price and information.

TINSLEY
LABORATORIES, INC.
2526 Grove Street · Berkeley 4, California

CIRCLE 86 ON READER-SERVICE CARD

"Telephone Quality"
Stromberg-Carlson
RELAYS



. . . featuring new high-voltage types for test equipment or other high-voltage applications.

THE insulation in the new relays withstands 1500 volts A.C.—three times normal. These high-voltage models are available in Types A, B and E. They are the latest additions to the Stromberg-Carlson line of twin contact relays—all available for immediate delivery.

The following regular types are representative of our complete line:

Type A: *general-purpose relay with up to 20 Form "A" spring combinations. This relay is excellent for switching operations.*

Type B: *a gang-type relay with up to 60 Form "A" spring combinations.*

Type BB: *relay accommodates up to 100 Form "A" springs.*

Type C: *two relays on the same frame. A "must" where space is at a premium.*

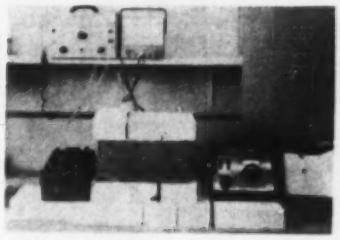
Type E: *has the same characteristics as the Type A relay, plus universal mounting arrangement. Interchangeable with many other makes.*

Details on request. In Atlanta call TRINITY 5-7467; Chicago: STATE 2-4235; Kansas City: HARRISON 1-6618; Rochester: HUBBARD 2-2200; San Francisco: OXFORD 7-3630. Or write to Telecommunication Division, 113 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

CIRCLE 87 ON READER-SERVICE CARD

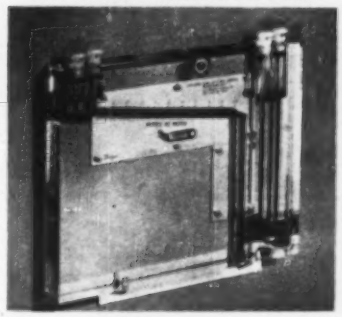
SWAGING TUBE CHECKS



New testing apparatus checks TE value in Crushable Insulation Tubing made from magnesium-oxide- and aluminum-oxide materials for metal-sheathed thermocouples etc. TE value represents temperature in °C at which resistivity of 1 cm^3 of material (MgO or Al_2O_3) is equal to 10 minus 6 ohms. Bulletin gives details.—*Du-Co Ceramics Co., Saxonburg, Penna.*

CIRCLE 212 ON READER-SERVICE CARD

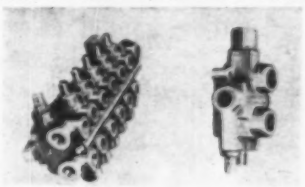
INCLINED MANOMETERS



New line of Inclined-vertical Manometers for use with pitot tubes and in flow measurement is available in single- and double-column styles, stationary or portable, in various ranges up to 23" WC. Accuracy is ±1% Fabricated from solid blocks of clear acrylic plastic, they are virtually unbreakable.—*F. W. Dwyer Mfg. Co., Dept. IT-5, Box 373, Michigan City, Ind.*

CIRCLE 213 ON READER-SERVICE CARD

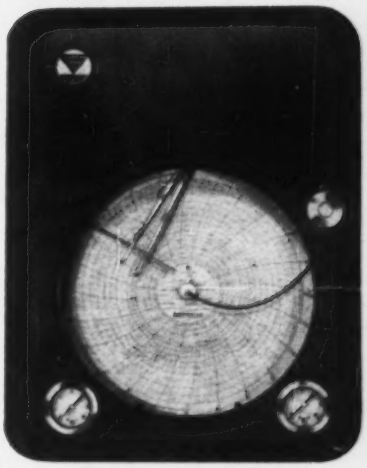
DIRECTIONAL CONTROL VALVE



New line of heavy-duty 2000-psi, 20-, 30-, and 40-gpm Directional Control Valves is built in both single valve (V20 Series) and multiple valve units (MV20 Series). Features include (1) differential pressure relief valves, (2) ample cross-sectional areas, (3) internal load check.—*Century Engineering Co., Waukesha, Wis.*

CIRCLE 214 ON READER-SERVICE CARD

AMERICAN®



SERIES
A-88
CONTROLLERS

Designed to give rugged, dependable performance, Series A-88 Controllers provide versatile, positive control of . . . Flow, Pressure, Liquid Level and other continuous process variables . . . accurately and automatically.

- Rugged, null-type non-bleed Relay.
- Simple, in-the-field linkage adjustment.
- Maximum Proportional Band changes with minimum output pressure changes.
- Proportional Band easily widened without disconnecting instrument tubing.
- Spring-closing Reset Valve sealed with bellows and calibrated according to time.

Ask for Bulletin CT-49.

AMERICAN®
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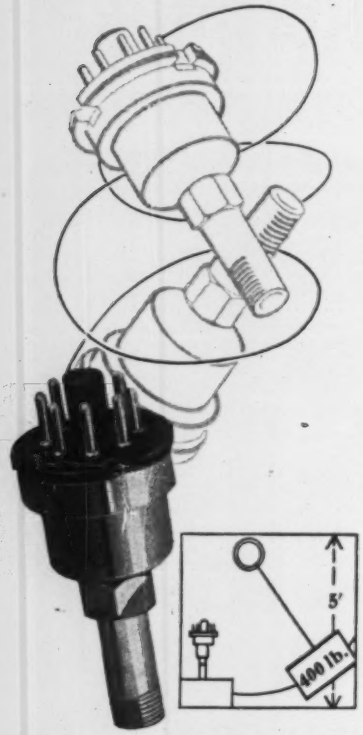
INCORPORATED (ESTABLISHED 1836)
General Offices: Philadelphia 16, Pa.
Sales Offices in Principal Cities

CIRCLE 88 ON READER-SERVICE CARD

SYNONYMS IN ACTION

rug'ged ness (rŭg'ĕd nĕs), n. strong; sturdy; hardy

Hast'ings gauge tube (hāst'ĭngs gāj tūb), n. strong; sturdy; hardy



RUGGED **HASTINGS GAUGE TUBE UNHARMED** FROM SHOCK IN 400 LB. DROP HAMMER TEST

Ruggedness is *defined as* "strong, sturdy, hardy". But ruggedness is *demonstrated* by this shock test of a Hastings Gauge Tube conducted to government specification MIL 901B. A 400 lb. drop hammer was released to apply shocks to the above pictured Gauge Tube in all three planes from 1, 3 and 5 feet. The Hastings Gauge Tube remained unharmed and fully operable.

For every application where ruggedness, plus sensitivity, is needed in the measurement of vacuum, Hastings gauges offer advantages not found in other vacuum gauges. Their special patented heated thermopile construction, compensated for temperature and rate of change of temperature, offers rapid and accurate response. Hastings direct reading gauges, free from tube burn-out or glass breakage, are available in four hard-to-measure ranges, 0-100μ Hg; 0-1000μ Hg; 0-200mm Hg and 10-200mm Hg.

Send for Free Catalog No. 175 for more information on Hastings Vacuum Gauges, Controllers, Recorders.

HASTINGS-RAYDIST, Inc.

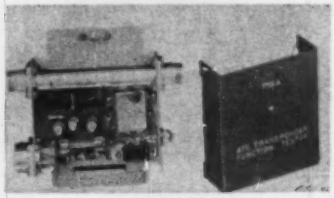
1401 Newcomb Avenue,

Hampton, Virginia PArk 3-6531

CIRCLE 89 ON READER-SERVICE CARD

IGS NEW INSTRUMENTS

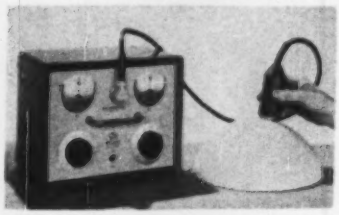
TRANSPONDER



New Transponder Function Tester, Model 758, provides two valuable features: (1) a panel light informs the pilot when his transponder is being interrogated during flight, and (2) by use of a switch, either on the ground or in the air, the pilot is informed of the operating condition of the transponder. Details in bulletin.—*Wilcox Electric Co., Inc., Fourteenth and Chestnut, Kansas City 27, Mo.*

CIRCLE 215 ON READER-SERVICE CARD

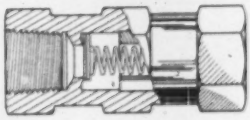
TEST PROBES



New Probes with the Model 168 D-K Analyzer for non-destructive examination of many finished parts made of glass-reinforced plastics and other insulating materials by measuring the dielectric constant and dissipation factor of insulating materials. Probes are now available for examining spherically-shaped surfaces as illustrated.—*Delsen Corporation, 719 W. Broadway, Glendale 4, Calif.*

CIRCLE 216 ON READER-SERVICE CARD

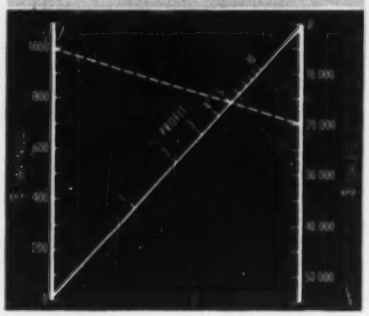
CHECK VALVE



New disc-type Check Valve, 900-Series, has no moving parts except a small disc. Opening pressure is 2-8 psig and the soft surface disc provides dead tight sealing at all pressures in air, oil, and water. Available in brass in ¼", ⅜", and ½" female NPT.—*Bodnar and McDermott Mfg. Co., 19 Beechwood Ave., Mount Vernon, N. Y.*

CIRCLE 217 ON READER-SERVICE CARD

HOW E-A RECORDERS CAN HELP YOU BOOST YOUR PROFITS



Increasing your sales isn't the only way to boost your profits.

You can also do it by reducing wastes of time, men, materials, machines and power—with the help of Esterline-Angus Recording Instruments.

Suppose that the information you get from an E-A Recorder shows how you can save $1,000. How important such a saving really is, is shown by the chart, above.

Lay a ruler from $1,000 (on the left) across the diagonal scale at your rate of profit (assumed in this example to be 5%).

Then look along your ruler to the scale at the right. You'll *find your $1,000 savings is equivalent to the profit on $20,000 on sales.*

With Esterline-Angus Recorders you can ferret out production losses by keeping track of the factors that enter into the cost of producing your product—factors such as production rate, down time, motor loading and electrical power supply conditions.

Send for Bulletin 958

Let your nearby E-A Representative help you. Write for his name and address.

E-A

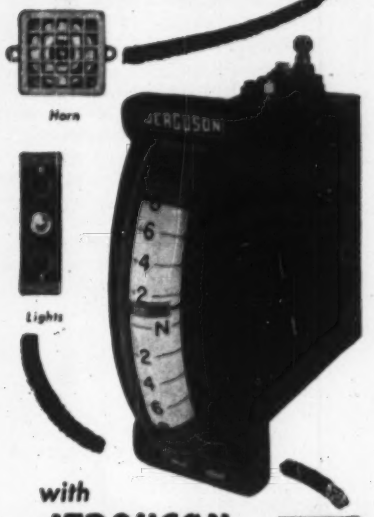
The ESTERLINE-ANGUS Company

No. 1 in fine Recording Instruments for more than 50 years.

DEPT. G, BOX 596, INDIANAPOLIS 6, INDIANA

CIRCLE 90 ON READER-SERVICE CARD

You Get
COMPLETE PROTECTION



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(to ½ of 1% of scale)
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REPEATS, REPEATS, REPEATS, REPEATS, REPEATS, REPEATS,
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The Convex Scale Truscale gives full 180° visibility.

Get complete protection for your valuable boilers and tanks. Ask for Truscale Catalog showing Standard, Inclined and Red Flasher Truscales in all WSP.

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Gages and Valves for the Observation of Liquids and Levels
JERGUSON GAGE & VALVE COMPANY
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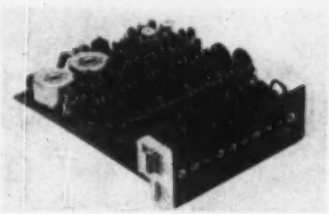
CIRCLE 91 ON READER-SERVICE CARD

LOW-COST MOTOR

New low-cost fhp Electric Motors, Type TW Series, have externally removable brushes which give quick, easy replacement, and are not ordinarily available on low-cost motors.—*Redmond Co., Inc., Owosso, Mich.*

CIRCLE 218 ON READER-SERVICE CARD

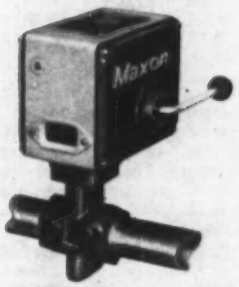
DECADE COUNTER



New one-megacycle transistorized Decade Counter, Model 1302, with 10-number display, features single operating voltage of +100 v/50 ma. Input requirements: −8 to −15 v, 0.2 μsec. Output: −10 v. Plugs into standard, 10-pin printed circuit connector.—*Robotomics, Inc., 4624 E. Garfield, Phoenix, Ariz.*

CIRCLE 219 ON READER-SERVICE CARD

SAFETY SHUT-OFF VALVE



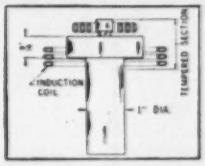
New Maxon Series 800 Manual-Reset Valve shuts off flow of fuel automatically and instantly upon any break in the electric power or safety circuit. It is approved and listed by testing laboratories of Associated Factory Mutuals, UL, and Canadian Standards Association.—*Maxon Premix Burner Co., 201 E. 18th St., Muncie, Ind.*

CIRCLE 220 ON READER-SERVICE CARD

LepeL
HIGH FREQUENCY INDUCTION
HEATING UNITS

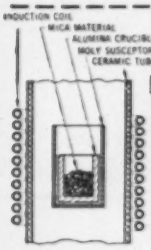
Lepel induction heating equipment represents the most advanced thought in the field of electronics . . . the most practical and efficient source of heat developed for numerous industrial applications. You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS



Punch Heads Selectively Tempered

Diagram shows arrangement for selectively tempering heads of alloy steel punches. The use of a combination type solenoid and pancake induction coil reduces hardness from Rc 55/56 to Rc 41/44, improving resistance to brittle fracture at the head of the punch. In this case a heating cycle of 55 seconds provides uniform tempering. A multiple position fixture, processing 4 pieces at one time, speeds up production.



Heating Non-Conducting Materials To High Temperatures

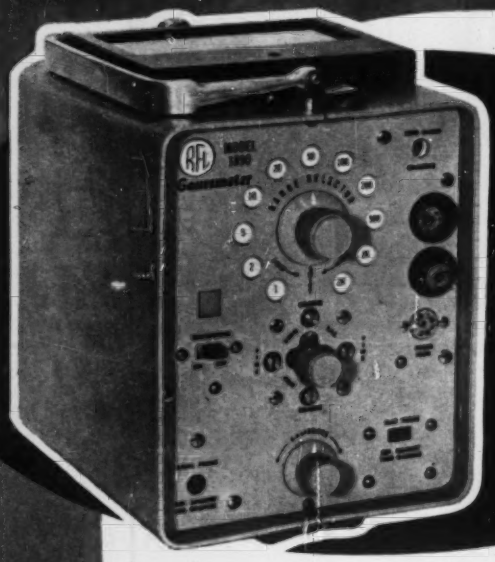
Laboratory analyses frequently require heating of non-conducting materials to temperatures of 3,000 to 3,500° F. in vacuum or special atmosphere. This can be accomplished by induction heating with the aid of a metal susceptor. Diagram shows the fusion of mica samples in an alumina crucible, using molybdenum susceptor. A ceramic tube surrounding the susceptor isolates the work for fusion in a vacuum. The molybdenum susceptor is heated by induction, which in turn, heats the crucible by radiation.

WRITE FOR NEW LEPEL CATALOG
Electronic Tube Generators from 1 Kw to 100 Kw
Spark Gap Converters from 2 Kw to 30 Kw

LepeL HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.

CIRCLE 92 ON READER-SERVICE CARD

Analyze Magnetic Circuits

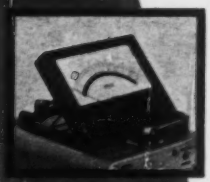


Versatile, Transistorized Instrument Measures DC to 400 cps Fields Directly

RFL Model 1890

Gaussmeter

measures flux densities from 0.1 to 20,000 gausses with .01-gauss resolution



Sensitive enough to register half-scale deflection for the earth's magnetic field, the Model 1890 provides a selection of 14 overlapping ranges from 1 gauss full-scale to 20K gausses. Accuracy over all ranges, using standard reference magnet, is better than 3%, with repeatability of meter readings better than 0.5%.

Temperature stable, InAs flat and axial probes are encapsulated in glass reinforced epoxy for durability and safe use around exposed electrical circuits.

The indicating meter is calibrated in gausses, has mirror scale, knife edge pointer and can be adjusted to four positions for most comfortable reading.

Meter has flexible leads, can be removed from cabinet and placed next to magnet structure being measured for most accurate reading. Jacks for external recorder output (1 ma. into 1500 ohm max.) and oscilloscope (2 volts max.) are also provided. Choice of plug-in AC supply or battery pack for portable or field use. Price $430, with flat probe and battery supply.

Performance is rigidly guaranteed. Prices are f.o.b. Boonton, N.J. and subject to change without notice.

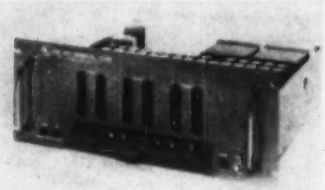
SEND FOR TECH. DATA

For additional information, including application data, write or phone DE 4-3100. Demonstrations available by local representatives.

Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

CIRCLE 93 ON READER-SERVICE CARD

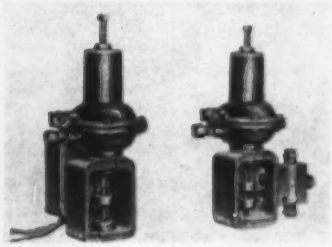
TIME CODE GENERATOR



New time code generator, ZA-803, supplies 24-hr, 20-bit time-of-day code which is read out once per sec. at a rate of 25 pps. It has frequency stability of 3 parts in 10^9, equivalent to one sec. per month. Provision is made for use of an external 1-mc or 100-kc frequency standard when greater accuracies are required.—*Electronic Engineering Co., of California, 1601 E. Chestnut Ave., Santa Ana, Calif.*

CIRCLE 221 ON READER-SERVICE CARD

PRESSURE SWITCH



New diaphragm-operated adjustable pressure switch Model CADM has 3-way snap action micro valve for pneumatic control systems; Model CADMEX has explosion-proof, U-L and CSA approved Microswitch for electric control.—*Instruments, Inc., Box 556, Tulsa, Okla.*

CIRCLE 222 ON READER-SERVICE CARD

CARD-TO-TAPE COMPUTER

New IBM 1401 E allows users to convert from punched cards to tape, but does not require high speed tape systems. Key component of 1401 E is new IBM 7330 Magnetic Tape Unit which reads data up to 20 times faster and writes out results at more than 60 times the rate of punched card equipment.—*International Business Machines Corp., Data Processing Div., 112 E. Post Rd., White Plains, N. Y.*

CIRCLE 223 ON READER-SERVICE CARD

WORLD'S MOST ACCURATE AIR-PRESSURE REGULATOR

- **Holds pressure to 1/5 of 1/10 of 1% of its range over substantial variations in supply pressure, flow, and ambient temperature. Resolution: 1 part in 10,000 of range.**
- **No exhaust-valve "pick-up" or initial drop-off on dead-end service. No drift with time or periodic shutdown.**
- **Designed for rugged service and minimum maintenance.**
- **50,000 user-tested for 6 years. Accepted as *primary standard of reference*.**

You can prove it! This new air pressure regulator is the world's most accurate and reliable device for precise control of air or gas pressure. Yet it costs no more than other pilot-operated regulators.

Key to its unequalled accuracy and instant response is its patented high-gain servo design, which uses regulated rather than supply pressure, and its stainless steel pressure capsule

Available in 2-25, 3-60, or 3-120 psi ranges for ⅛", ¼", or ⅜" NPT pipe at 15 U.S. stocking points. Standard trade and quantity discounts. *Write now for data sheet and prices.*

Some territories are still open for qualified technical sales representatives.

Lexington Controls
INCORPORATED®
P. O. BOX 132-D, BURLINGTON, MASS.
PROTECTED BY U.S. AND FOREIGN PATENTS AND PATENTS PENDING.

CIRCLE 94 ON READER-SERVICE CARD

Thermocouple Alloy

TRADE NAMES vs. ISA* STANDARDS

New data on Thermocouple alloys

Trade names CAN protect you . . . from improvements.

Specify Type K thermocouple wire per ISA Standards . . . and ask your supplier about his experience with the new Thermo-Kanthal alloys.

Their increased stable life means more accurate readings for longer periods . . . with no change in instrumentation required.

If your supplier's tests are not completed, write for Thermo-Kanthal Alloy Bulletin and lower prices.

May we quote on your bare and insulated wire requirements?

KANTHAL

* Instrument Society of America

THE KANTHAL CORPORATION
17 Amelia Place, Stamford, Conn.
Canadian Representative
Ferro Enamels, Oakville, Ont.

CIRCLE 96 ON READER-SERVICE CARD

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ALUMINUM
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ARSENIC TRISULPHIDE
BARIUM TITANATE
BISMUTH
BRASS
CARBORUNDUM
CERAMIC
COBALT FERRITE
COPPER
*CORNING 707
*CORNING 7052
COPROUS BROMIDE
FERRITE
FERROX
**FLUORIDE, CALCIUM
**FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GALLIUM ARSENIDE
GARNET
GERMANIUM
GOLD
INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM
MAGNETIC PLUMBITE
MELAMINE FIBER GLASS
MICA, SYNTHETIC
NICKEL OXIDE
PLATINUM
POTASSIUM BROMIDE
*PYREX
*QUARTZ, CRYSTAL
*QUARTZ, FUSED
**SAPPHIRE
**SODIUM CHLORIDE
**STEEL
STRONTIUM TITANATE
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TITANIUM DIOXIDE
*VYCOR
*X-RAY LEAD GLASS
ALL TYPES KNOWN GLASS

* Carried in stock
** Purchased for orders

CIRCLE 95 ON READER-SERVICE CARD

GREEN PANTOGRAPH ENGRAVERS

● ELIMINATE DELAYS!
● KEEP YOUR OPERATING COSTS WHERE THEY SHOULD BE!

PORTABLE 40-POUND BENCH MODEL 106

Here is a speedy, economical 2 or 3-dimensional engraver used by thousands of dollar-conscious companies. It features 5 positive, accurate pantographic ratios; ball bearing spindle with 3 speeds up to 14,000 rpm. Is supplied with one copy carrier that accepts all standard master type sizes. Will actually work up to 10" by any width. Height of pantograph and position of cutter are continuously adjustable.

You Make Your Own Engraved Nameplates!

MODEL D-2 HEAVY-DUTY 2-DIMENSIONAL
Pantograph for milling, drilling and engraving.

Vertical adjustment of copy table automatic with Pantograph. Features: unobstructed on 3 sides to take large work; micrometer adjustment for depth of cut; ball bearing construction throughout; spindle speeds up to 26,000 rpm for engraving or machining; vertical range over 10"; ratios 2 to 1 to infinity — master copy area 26" x 10"

NEW MODEL D2-201 PNEUMATIC ATTACHMENT

for use with Model D2 Pantograph Engraver to rapidly drill holes in printed circuits by tracing templates. Drills as many as 100 holes per minute. Equipped with foot switch; spindle air cylinder; regulating valve and pressure gauge; filter and oiler. It's ready to use as soon as it's attached to an air compressor

Write or call for full details and prices.

GREEN INSTRUMENT COMPANY, INC.
Dept. 83 295 Vassar St.
Cambridge 39 Mass. Tel. ELiot 4-2989

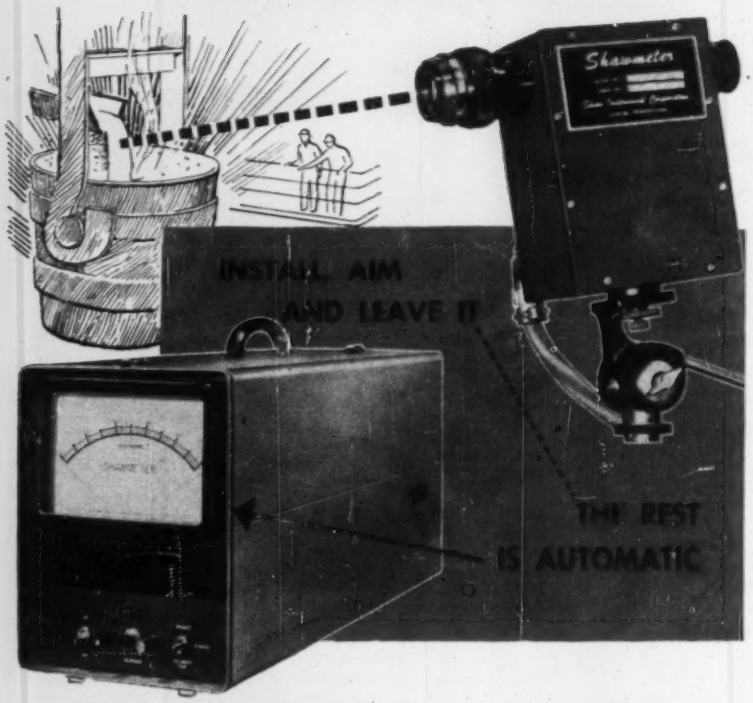
CIRCLE 97 ON READER-SERVICE CARD

Measure High Temperatures

EASILY, ACCURATELY

with the

SHAWMETER®



The SHAWMETER is an automatic, direct-reading, two-color pyrometer for indicating, recording or controlling temperatures up to 6500°F.

Measures the temperature of flowing metal, or of moving or stationary objects. No emissivity correction needed. Temperatures may be measured at a considerable distance from the object.

Accurate, sensitive, rugged. Write for complete details.

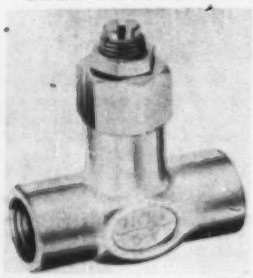
SHAW INSTRUMENT CORPORATION

CERAMIC-METAL SEALS • NUCLEAR and ELECTRONIC INSTRUMENTATION

P. O. Box L-46 Latrobe, Pennsylvania

CIRCLE 98 ON READER-SERVICE CARD

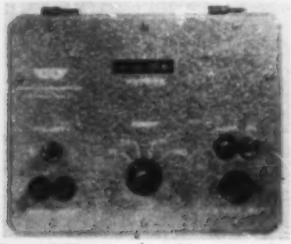
GAGE PROTECTOR



New 530 gage protector with maximum set pressure protection point of 1000 psig will handle inlet pressures up to 3000 psig from −10° to 200°F. Unit is supplied with 3 range springs covering 30 to 150, 150 to 500, and 500 to 1000 psig.—*Hoke Inc., 1 Tenakill Park, Cresskill, N. J.*

CIRCLE 224 ON READER-SERVICE CARD

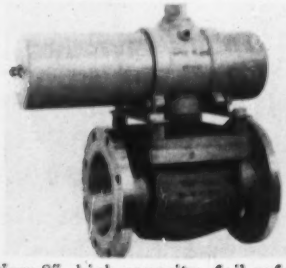
PORTABLE DC VOLTMETER



New BH190 portable d-c digital voltmeter contains analog-to-digital conversion system, a tape-slidewire potentiometer with 144" long resistance element, calibrated and geared to an in-line counter for readout accuracy to 0.1% in normal ambient temperature. Calibration of measuring system better than 0.05%; resolution better than 0.02%. Available with a maximum of 4 ranges from .020 to 10,000-v dc.—*Howell Instruments, Inc., 3479 W. Vickery Blvd., Ft. Worth 7, Texas.*

CIRCLE 225 ON READER-SERVICE CARD

BALL VALVE



New 8", high-capacity, fail-safe industrial Model 731 V Flo-Ball valve with spring return is top loading for easy access to internal assembly without removal from the line. Rated at 150 lb ASA, it is equipped with close coupled, compact, air-operated actuator with manual override.—*Hydromatics, Inc., 5 Lawrence St., Bloomfield, N. J.*

CIRCLE 226 ON READER-SERVICE CARD

THE EASY WAY to check environmental performance against prescribed MIL SPECS

To ensure that products sustain optimum performance characteristics during and after exposure to extremes of temperature and humidity, a great many MIL SPECS require precise environmental testing prior to shipment.

Aminco's Climate Lab simplifies this procedure and ensures highly dependable results. The Formica Corporation now uses two Climate Labs (one shown at right) to check various properties of plastic laminates. For example, laminate Grade XXXPM-36 is checked against MIL-P-3115B for insulation resistance performance. This Mil Spec requires that the material be subjected to a temperature of 35°C and a relative humidity of 90% for a period of 96 hours. It further specifies that a variation of not more than ±1°C may exist, and not more than ±2% RH.

The Aminco Climate Labs at Formica assure constancies even closer than prescribed. Inside the tightly sealed test space, desired environmental conditions are established and maintained constant within ±1% RH and ±1°F on a day-in, day-out basis.

The built-in program controller permits many combinations of varying constant temperature and/or humidity. A Pyrex inner door permits observation of the sample during test without disturbing the closely controlled environmental conditions.

By means of teflon-insulated feed-through electric terminals installed at the rear of the test chamber, power and external instrumentation may be connected to electric components during the test. This permits such checks as measurement of current leakage between adjacent conductors on printed circuits, and measurement of insulation resistance of samples.

FULL INFORMATION IN
AMINCO BULLETIN 501/59, IC
FREE ON REQUEST.

AMINCO

AMERICAN INSTRUMENT CO., INC.

8030 Georgia Ave., Silver Spring, Md.

Photo courtesy Formica Labs where two Climate Labs are used to check performance characteristics of plastic laminates against various MIL SPECS

CIRCLE 99 ON READER-SERVICE CARD

NEW

DC driven CHOPPERS

No AC!

For battery-operated portable low-level d-c amplifiers and

For transistorized d-c amplifiers. Removes stray a-c signals from chassis wiring. Eliminates null offsets.

Write for Catalog 554

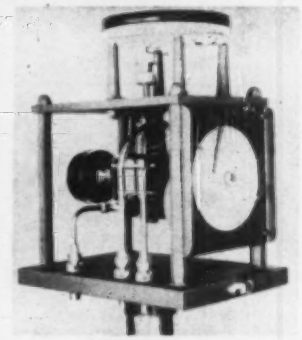
STEVENS
INCORPORATED
ARNOLD

7 ELKINS STREET
SOUTH BOSTON 27, MASS.

CIRCLE 100 ON READER-SERVICE CARD

NEW INSTRUMENTS

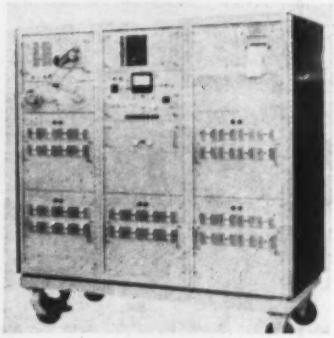
CONTINUOUS GAS SAMPLER



New continuous gas sampler, Model M-R, for the accurate determination of chemical and physical properties of gas will, over a period of 7 days, accumulate at a constant rate a sample of gas to a final pressure at or near 140 psig from the sample source, the minimum pressure of which is not less than 160 psig. Sample is gathered in a portable container and can be employed in any hazardous area where vapor-proof equipment is required. Bulletin 112 R-2.—*ARCCO Instrument Co., Inc., 7144 E. Condor St., Los Angeles 22, Calif.*

CIRCLE 227 ON READER-SERVICE CARD

AUTOMATIC CABLE TESTER

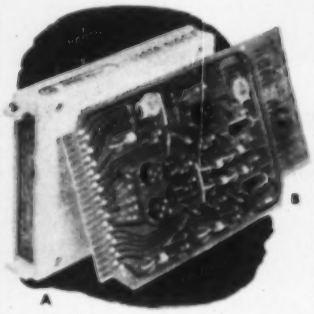


New Model 230 tape-programmed cable harness analyzer features programmed continuity, leakage from wire under test to all other wires, complete random selection, 100% branch testing capabilities, search scan and fault print-out. Search scan permits rapid location of all existing faults by holding one end of the wire under test, while scanning all others.—*California Technical Industries, Div. of Textron, Inc., 1421 Old Country Rd., Belmont, Calif.*

CIRCLE 228 ON READER-SERVICE CARD

THESE TWO FLIP-FLOPS ARE

Identical!



DIFFERENT PACKAGES, YES

— but the two high-speed flip-flop modules shown here are electrically *exactly the same* . . . just two more of the wide selection of Harvey-Wells Data-Bloc and Data-Pac logical building block matched pairs that make possible an entirely new way to design digital systems.

Here's why: Harvey-Wells high speed Data Blocs feature logic diagram front panels for rapid breadboarding of any digital system configuration — the compatible, easy-to-use Data Blocs are jumpered together until the new system design is thoroughly checked out. With the breadboard complete, the basic design kit Data Blocs are replaced with their Data-Pac compact electrical equivalents. The result — a working, rugged prototype or final system.

Write today for your copy of a *technical* brochure that gives full details about this new way to design digital systems.

A. Data Bloc Flip-Flop 1011

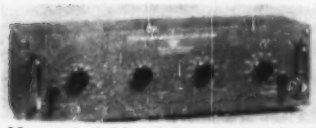
B. Data Pac Flip-Flop 2011

Speed . . . 5 mc
Inputs . . . Set, Clear, Complement
Internal Delay . . . 0.1 usec.

Harvey-WELLS ELECTRONICS INC.
14 HURON DRIVE NATICK, MASS.

CIRCLE 101 ON READER-SERVICE CARD

VARIABLE DELAY LINES



New variable delay network features ratio of rise time to total delay less than 1.5%, distortion at output terminal less than 2%, total delay as long as 0.2 sec, output impedance to match any low impedance load from 200-1000 ohms, time delay variable of 0.0001 times total delay, attenuation as low as 0.08 db/ms delay, stability better than 5 ppm/°C. Input voltage can be as high as 200 volts without saturation. Three different types available.—*Ad-Yu Electronics Lab., Inc., 249-259 Terhune Ave., Passaic, N. J.*

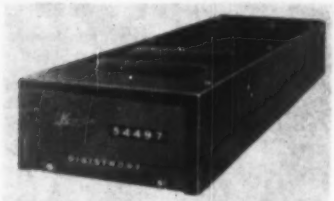
CIRCLE 229 ON READER-SERVICE CARD

PRECISION OVENS

New Model 1201 oven features internal temperature stability of ±0.01°C at 70°C, over ambient range of 0° to +50°C. Proportional controller is fully transistorized and powered from 28-v dc supply. Internal chamber has volume of 20 cu in.—*Airtronics, Inc., 5522 Dorsey Lane, Washington 16, D. C.*

CIRCLE 230 ON READER-SERVICE CARD

DIGITAL DISPLAY DEVICE

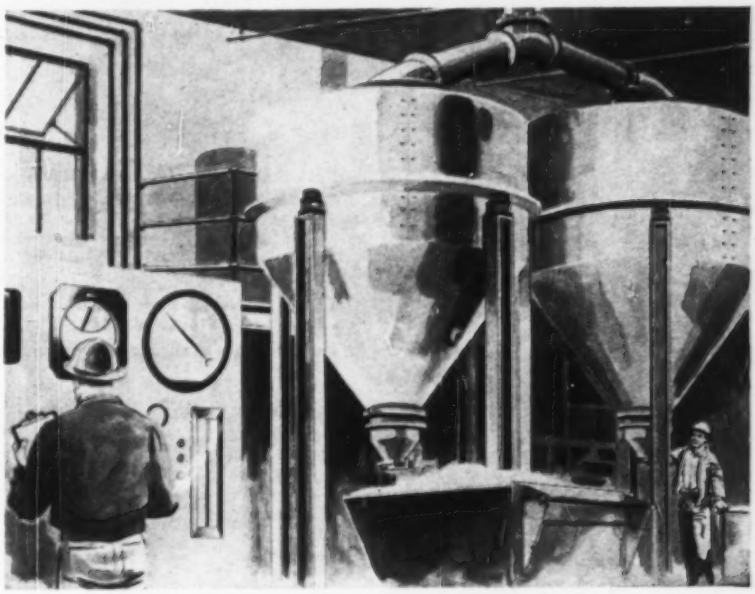


New Digistrobe digital display employs stroboscopic principle to provide an in-line, in-plane, high-definition, white-on-black display, far superior to existing units. Through use of a unique shutter arrangements, a single diode-encoding matrix is shared by all columns, resulting in substantial savings in electronic components and circuitry. A single display can be used to sample several inputs on command, thus replacing as many as 15 individual displays of existing types.—*Kearfott Div., General Precision Inc., 1150 McBride Ave., Little Falls, N. Y.*

CIRCLE 231 ON READER-SERVICE CARD

EMERY ENGINEERED WEIGHING SYSTEM

Provides Maximum Accuracy for Pulverized Vitamin C Installation



Explosion-Proof Equipment Provides Control For Hopper-Filling Mechanism

A pharmaceutical manufacturer wanted to weigh powdered ascorbic acid as part of its process in making Vitamin C tablets. The powder is gathered in hoppers which weigh 3500 pounds and handle a maximum net load of 8750 pounds.

The conditions demanded that the equipment be explosion-proof and that the weighing signal be used to actuate automatically a diverting gate in the filling system which would switch the in-flow from one hopper to another.

An Emery Engineered Weighing System, based on the use of 4 Model EC-30 load cells and a hydraulic totalizer and using a 16" Emery Precision Indicator together with a Foxboro controller, handled the hopper-weighing job with an accuracy of ¼% of full range. Customer satisfaction is guaranteed.

If you have a tank, bin or hopper weighing problem which involves a control function, write today. Our literature is graphic, descriptive and easy to use in figuring a system for your installation. The A. H. Emery Company, Pine Street, New Canaan, Conn.

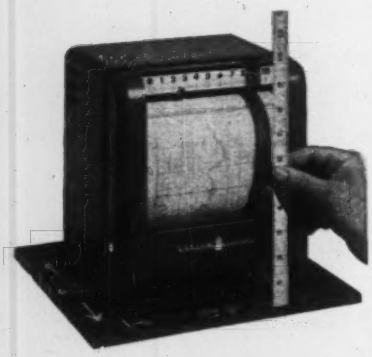
EMERY *Engineered* weighing systems

CIRCLE 102 ON READER-SERVICE CARD

VARIAN
Potentiometer
RECORDERS

Used by the thousands

because . . .



3. ANYWHERE USED, THEY

SAVE SPACE

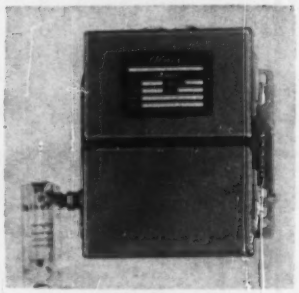
Equipment manufacturers praise the Varian G-11A because it fits neatly into instrument panels, occupying ¼th the space of a conventional-sized recorder. Lab men appreciate Varian's portable versions because they add so little clutter to bench or table.

1% limit of error; 1 or 2½ second full-scale balancing time; ranges from 0-9 millivolts to 0-100 volts; wide choice of speeds, accessories and charts; prices from $385. For all the facts, write the Instrument Division.

VARIAN associates
PALO ALTO 27, CALIFORNIA

CIRCLE 103 ON READER-SERVICE CARD

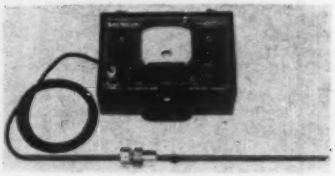
DEW POINT TRANSDUCER



New transducer Type No. 7600 has been developed to measure dew points from −20° to +60°F, and is particularly suited for outlet measurement of endothermic gas generators used in controlled atmosphere heat treating.—*Alnor Instrument Co., 420 N. LaSalle St., Chicago 10, Ill.*

CIRCLE 232 ON READER-SERVICE CARD

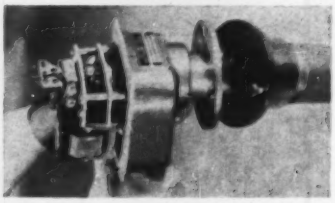
GAS VELOCITY METER



New velocity meter is designed and specially calibrated for use by gas utility companies. To obtain a velocity reading, a probe containing a sensing unit is inserted into the line through a standard 1" MPT pipe tap. Velocity, indicated directly on the meter, can be converted into standard cubic ft/hr from the quick-reference chart supplied with the meter.—*American Meter Co., 920 Payne Ave., Erie, Pa.*

CIRCLE 233 ON READER-SERVICE CARD

SOLID-STATE FLAME DETECTOR



New solid-state flame detector, Type UF1100B, responds to radiation in the spectrum from 2000 to 2800 angstrom units and operates effectively at ambient temperatures from −20° to +300°F. Detector relay for alarm actuation has a SPDT contact arrangement and a 1 or 2-sec time delay. Relay contact rating is 2 amps at 125-v ac or 2 amps at 25-v dc.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

CIRCLE 234 ON READER-SERVICE CARD

Electronic Circuitry for Instruments and Equipment

by M. H. Aronson. "Comprehensive source book on instrument circuitry," this complete home-study text includes 458 multiple-choice questions (and answers), 215 illustrations, 10 tables, comprehensive index. Paperbound, 324 pages, 1957 (revised edition). **$2.00**

100 Electronic Circuits

Vol. 1 and Vol. 2

by M. H. Aronson and C. F. Kezer . . . covers amplifiers, oscillators, pulse circuits, phase shifters, etc. Complete with all circuit component values and response specifications. Paper, 180 pages, 1957, 1959 each **$2.00**

Printed Circuitry

by Allan Lytel. A valuable working tool; includes alternative and recommended practice for each step in design and production of printed circuits; a buyer's guide to special components; and "how to" service data. Paperbound, illustrated, 192 pages, 1957 **$2.00**

Maintenance and Servicing of Electrical Instruments

by James Spencer. Useful to all instrument users, service men, switchboard attendants testing engineers, and others, this book covers construction, testing, applications, principles of operation and maintenance of all kinds of electrical indicating instruments. Clothbound, 274 illustrations, 280 pages, 1951 (third edition). **$2.00**

Strain Gage Instrumentation

edited by Aronson and Nelson. ". . . a practical text . . . covers fundamentals, basic bridge circuits, typical applications, and surveys typical commercial instruments which use or are used with strain gages." Paper, 110 pages, illustrated, indexed by company, author, and subject, 1958. **$2.00**

Nuclear Reactors for Industry and Universities

edited by E. H. Wakefield. The several distinguished authors and editor Wakefield cover types, availability (1954), operation, protection, control, experiments, legal aspects, and present a detailed cost study. Cloth, 92 pages, illustrated, 1954. **$2.00**

Instruments Publishing Co.
845 Ridge Avenue
Pittsburgh 12, Pennsylvania

MINI TEMP RECORDER

New Temprint recorder operates directly from a thermocouple and has a meter movement sensitive enough to permit temperature recording without a signal amplifier. Only electrical connections necessary are the thermocouple and a 115-V ac line. Minimum temperature span is 0° to 500°F; maximum span is 0° to 2500°F. Accuracy is ±2% of full scale. Standard chart speed is 1"/hr.—*Assembly Products, Inc., Chesterland, Ohio.*

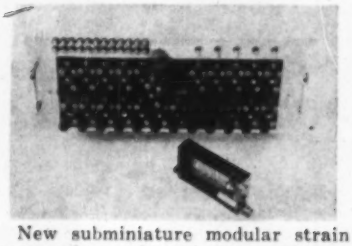
CIRCLE 235 ON READER-SERVICE CARD

VERNIER PRESSURE REGULATOR

New A-53 Vernator is designed for ultra precise pressure regulation in non-flow pneumatic systems. Makes precise pressure regulation possible over range of 0.1 to 1000 psi while maintaining actuating forces at a low level.—*Astromics, 611 W. Harvard St., Glendale, Calif.*

CIRCLE 236 ON READER-SERVICE CARD

MINI STRAIN GAGE



New subminiature modular strain gage and transducer input conditioner Model 1-202AM fits trend toward standardization of transducers. It cancels effects of long lines by utilizing 6-wire, single shunt calibration technique. Can accommodate any number of active arms (1, 2, or 4).—*B & F Instruments, Inc., 3644 N. Lawrence St., Phila. 40, Pa.*

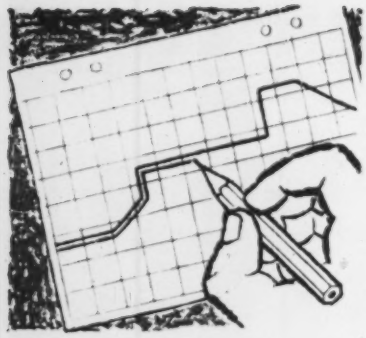
CIRCLE 237 ON READER-SERVICE CARD

SENSITIVE SENTINEL

is a good description of the Barton 257 differential pressure indicating switch. Accurate, responsive, easy to read and infinitely dependable, the 257 is ideal for energizing alarm circuits when limits of flow, level, or differential pressure are exceeded. Like many Barton instruments, the 257 D.P. switch has as its heart the rupture-proof dual bellows Barton meter body—proved beyond doubt to be the finest in the field. For new standards of accuracy and dependability in your measurement and control instruments, look to the leader—buy **BARTON**®

BARTON INSTRUMENT CORPORATION • MONTEREY PARK, CALIFORNIA

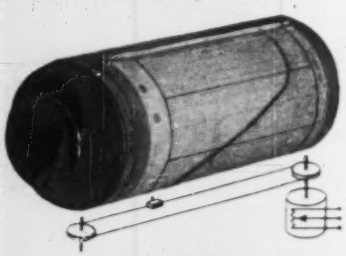
CIRCLE 105 ON READER-SERVICE CARD



Plot your program with a pencil on ordinary graph paper

DATA-TRAK®

will **follow** it



Now, with only an ordinary graphite pencil and graph paper, you can feed program instructions to automatic process controls. Data-Trak follows pencil-drawn graphs anyone can prepare. High degrees of accuracy and reliability result from use of unique capacitive curve-following principle. Potentiometer output is proportional to drawn curve.

Graphs last indefinitely because stylus doesn't touch the paper. Data-Trak drum speed is variable, can even be programmed automatically. Drum rotates continuously on some models for cyclic programming.

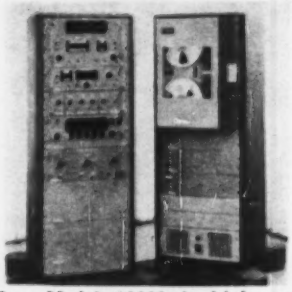
RI RESEARCH INCORPORATED

Write Dept. IC, Box 6164, Minneapolis 24, Minn.

CIRCLE 106 ON READER-SERVICE CARD

ICS NEW INSTRUMENTS

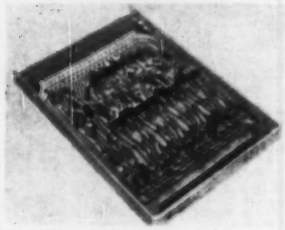
DATA ACQUISITION SYSTEMS



New Model 10000 is high speed, solid-state data recording system for acquisition and processing of operating and test data. Basic system is made up of 3 components: Model 701 high speed scanner in 5-channel multiples; Model 721 analog-to-digital converter; and Model 7415 output format control.—*Electro Instruments, Inc., 3540 Aero Court, San Diego 11, Calif.*

CIRCLE 238 ON READER-SERVICE CARD

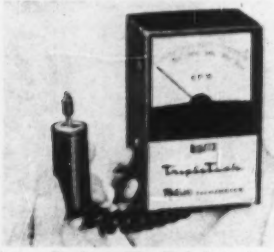
QUADRUPLE FLIP-FLOP



New Type 4213 unit features 4 static flip-flops built-in shifting or buffering gates, and self-contained pulse amplifier. Speed is variable from 0 to 500 kc. Flip-flops may be individually set or cleared.—*Digital Equipment Corp., Maynard, Mass.*

CIRCLE 239 ON READER-SERVICE CARD

HAND TACHOMETER



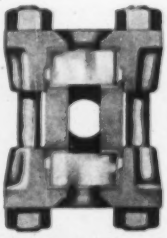
New Series 27 Tripletach hand tachometer comes in 3 types: Type A measures from 200 to 10,000 rpm; Type B from 100 to 5,000 rpm; Type C from 20 to 1000 rpm. Three scales, changed by a thumb switch, permit fine readings within these measuring ranges. Accuracy is ±1% of full scale deflection.—*Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

CIRCLE 240 ON READER-SERVICE CARD

Strahman

HIGH PRESSURE GAUGES

USED IN
REFINERIES
AND
CHEMICAL PLANTS
THROUGHOUT THE WORLD



THRU VISION

REFLEX
Single or Multiple Sections

TUBULAR

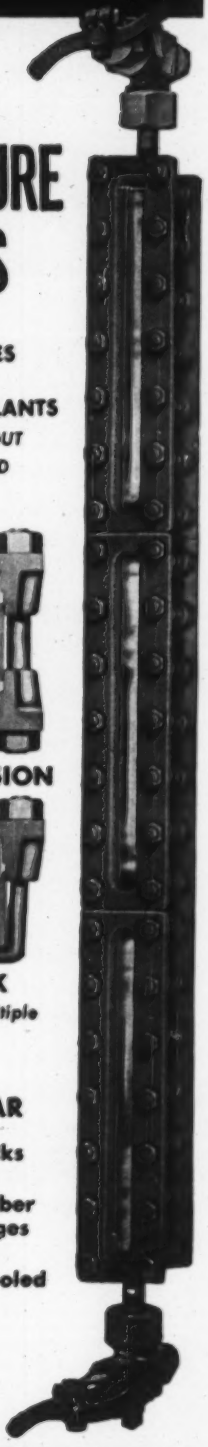
Gauge Cocks

•

Large Chamber Reflex Gauges

•

Heated or Cooled Gauges



SEND FOR
COMPLETE CATALOGUE

STRAHMAN VALVES, Inc.
NICOLET AVE., FLORHAM PARK, N. J.

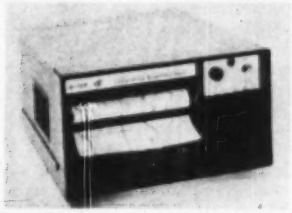
CIRCLE 107 ON READER-SERVICE CARD

CORROSION METER

New Model CK-2 Corrosometer is suited for either lab or in-the-field corrosion measurement. Weighs 11 lb, measures 12" x 10" x 5¼" in anodized case.—*Crest Instruments, 11808 S. Bloomfield Rd., Santa Fe Springs, Calif.*

CIRCLE 241 ON READER-SERVICE CARD

PORTABLE OSCILLOGRAPH



New Type 5-124 Oscillograph features 5-speed pushbutton controlled transmission, 200' record capacity of 7" paper, and writing speeds to 50,000 ips.—*Electro Mechanical Instrument Div., Consolidated Electrodynamics Corp., 300 Sierra Madre Villa, Pasadena, Calif.*

CIRCLE 242 ON READER-SERVICE CARD

MICRO DELAY PLUG-IN

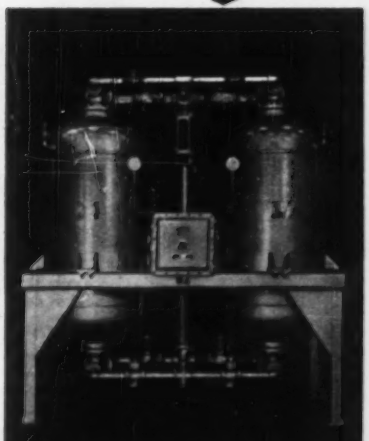
New micro delay plug-in Type 4209 provides precise trigger delay from 0 to 100 nanoseconds and resolution within 0.1 nanosecond (10^{-10} sec). It is inserted electrically into the external trigger channel of DuMont 425 direct digital readout high frequency oscilloscope, and a selector switch permits trigger source selection from the internal signal, from an external source, or from the internal fast rise generator.—*Allen B. Du Mont Laboratories Div., Fairchild Camera and Instrument Corp., Clifton, N. J.*

CIRCLE 243 ON READER-SERVICE CARD

REDUCE MAINTENANCE COSTS

Moisture and oil in your air system will result in costly repairs, down time, and even system failure. Moisture causes rust that clogs delicate sensing devices, slows down pneumatic controls, and in some cases, brings about total destruction of expensive equipment. Random oil in an air system forms sludges, gums and hard varnishes, causing instrumentation and control breakdown.

TRINITY



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Heat-Les

The Trinity Heat-les Dryer makes possible the driest air of all. This amazing dryer is being used in hundreds of industrial and military installations, and establishing new records for dependability, economy and performance.

Dewpoints to -200°F.

Low initial cost.

No heaters to replace or power.

No increase in air temperature.

Heat-les dryers are available in many sizes, for all pressures, from 1 scfm to 5000 scfm. Larger volumes may be handled through combinations of units. Also, in complete, unitized dry air systems, including compressor, accumulator and instrumentation.

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Thermocouples and Thermowells

TRINITY EQUIPMENT CORPORATION, CORTLAND, NEW YORK

CIRCLE 108 ON READER-SERVICE CARD

SEAMLESS METAL TUBE...
SOLID DIELECTRIC...
SOLID INNER CONDUCTOR

Widely accepted for its performance-proved characteristics over a wide range of applications.

COAXITUBE in Electronics assures lower attenuation and a minimum of false signal pick-up... is electrically equivalent to all RG/U cables.

COAXITUBE in electro-mechanics guarantees complete weather-proofing with minimum weight.

The center conductor is a solid or stranded copper wire, dielectric may be teflon or polyethylene. Outer conductor may be copper, aluminum or other non-ferrous alloy to meet requirements of weight, tensile strength or fatigue factors.

COAXITUBE is available in straight random lengths or coils to 40 feet... some in coils to 200 feet. It can also be furnished straightened, cut, stripped and formed in accordance with your sketch or drawing. Write for full technical details to—

PRECISION TUBE COMPANY, INC.
North Wales, Pa.

CIRCLE 109 ON READER-SERVICE CARD

NEW INSTRUMENTS

MECHANICAL COUNTER

New bi-directional mechanical counter Type CM-4-3000 has $\frac{1}{8}$" high numerals for applications where dependability, reading ease and low cost are important. Operating speed is 600 rpm continuous and operating torque approx. 1 oz-in. Input shaft is $\frac{1}{4}$" dia x $\frac{7}{8}$" long and can be supplied from either or both sides.—*Chicago Dynamic Industries, Inc., Precision Products Div.*, 1725 *Diversey Blvd., Chicago* 14, *Ill.*

CIRCLE 244 ON READER-SERVICE CARD

DC POWER SUPPLY

New Model P60-1 general-purpose power supply provides continuously variable output voltages in 3 ranges: 0 to 6, 0 to 30, and 0 to 60 v dc. Maximum output ripple is 50, 200, and 300 mv rms, respectively; output resistance is approximately 3, 4, and 6 ohms, respectively.—*Consolidated Avionics Corp.*, 800 *Shames Dr., Westbury, L. I., N. Y.*

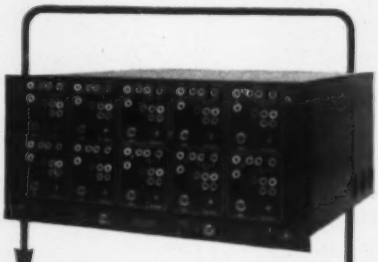
CIRCLE 245 ON READER-SERVICE CARD

D-P TRANSMITTERS

New Series BB differential-pressure transmitters are designed for use in primary plant instrumentation of pressurized water nuclear power plants. With unregulated ac input, output accuracy is ± ¾% dc. Standard d-p ranges are 0-90, 0-140, 0-200, 0-400 inches water; 0-10 and 0-220 psi.—*Consolidated Controls Corp., Bethel, Conn.*

CIRCLE 246 ON READER-SERVICE CARD

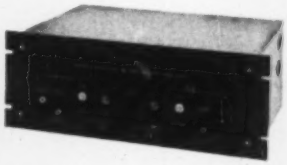
FROM PHILBRICK: 10 stabilized amplifiers in one supremely versatile manifold!



STABILIZED OPERATIONAL MANIFOLD

MODEL K7-A10

Contains 10 USA-3 Universal Stabilized Amplifiers. A precision instrument of unusual versatility. Permits fast, economical set-up of many instrument or computing configurations. Ideal as a low cost computor, with unusual flexibility as a "simulator" of large scale systems. Also well suited for industrial or production line test equipment applications. Price, **$1200**



POWER SUPPLY — MODEL R-300

As a power source for the K7-A10, we recommend this 300 ma regulated power supply, because its exceptional regulation and sub-millivolt noise allow it to serve also as a high accuracy reference voltage. Due to its ultra-conservative ratings, the R-300 will allow the K7-A10 to operate indefinitely, even under full load conditions (350 ma). Price, **$390**

- Available from stock
- Military equivalents available
- Technical data available on request

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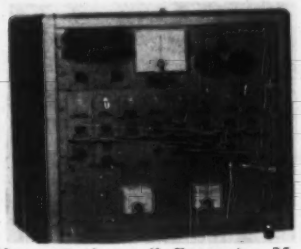
CIRCLE 110 ON READER-SERVICE CARD

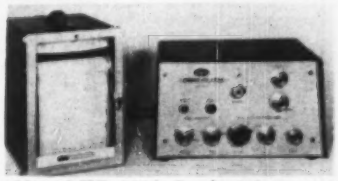
ROTATING COIL FLUXMETER



New rotating coil fluxmeter Model 601 measures or controls non-uniform fields to an accuracy of 0.01%. Can also be used as a field control unit to regulate a magnetic field.—*J. C. Carter Co., 671 W. 17th St., Costa Mesa, Calif.*

CIRCLE 247 ON READER-SERVICE CARD

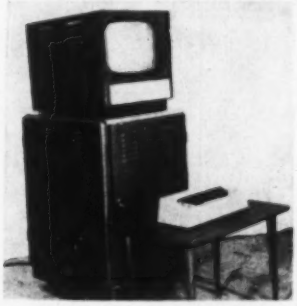
CONDUCTIVITY ANALYZER



New LKB 5300 Conductolyzer conductivity analyzer can be used where solution composition causes electrical conductance changes, such as from chromatography and electrophoresis columns. Three continuous-flow cells are available covering a range of 5×10^{-4} to 4 mhos, and having small hold-up volumes of from 0.02 to 0.05 ml. Bulletin 5300-EO1.—*LKB Instruments, Inc., 4840 Rugby Ave., Washington 14, D.C.*

CIRCLE 248 ON READER-SERVICE CARD

CHARACTER GENERATOR

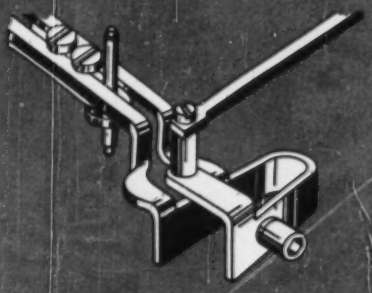


New DOTitron, character generation and display system, generates and displays alpha-numeric characters or any arbitrary patterns on the face of a conventional cathode-ray tube (either electrostatic or electromagnetic) or projection tube equipment. Display is in form of closely adjacent luminous dots positioned to generate the required patterns. The character selection and position order are in the form of parallel digital codes.—*Link Div., General Precision, Inc., Binghamton, N. Y.*

CIRCLE 249 ON READER-SERVICE CARD

HEISE GAUGES

MICRO-SLIDE



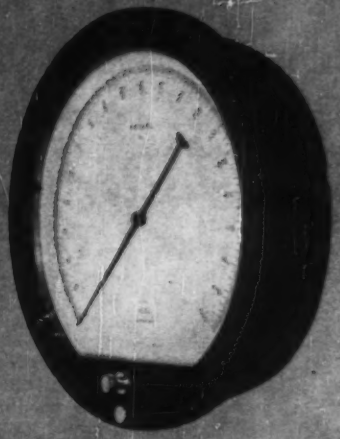
Highly favorable reaction among gauge users has followed the development of the Heise Micro-Slide adjustment. Systematic field recalibration of batteries of Heise gauges may now be directly and precisely effected with minimum time loss.

Calibration adjustments as fine as .0005 inches in the effective length of the sector slide may be quickly and conveniently applied.

Periodic recalibration of gauges may also be reduced as a result of the damping effect of the spring loaded adjustment which protects the setting from shock and vibration.

CONVENIENT PRECISION RECALIBRATION

The Micro-Slide comprises a spring loaded micrometer screw controlling the position of the link pivot. This screw may be conveniently adjusted with a standard Allen wrench. A flat spring cushions the assembly and protects the setting from shock or vibration.



Dial Sizes	FULL SCALE READING (P.S.I.)						
	0-15 to 0-5,000 inclusive	Over 0-5,000 and including 0-20,000	Over 0-20,000 and including 0-30,000	0 to 40,000	0 to 50,000	0 to 75,000	0 to 100,000
8½"	$183.50	$205.50	$238.50				
12"	$209.50	$231.50	$264.50	$275.50	$286.50	$336.50	$386.50
16"	$255.50	$277.50	$310.50	$321.50	$332.50	$382.50	$432.50

DELIVERY — 2 WEEKS FOR MOST RANGES — PRICE F.O.B. NEWTOWN

Request Catalog for SPECIAL FEATURES

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BROOK ROAD, NEWTOWN, CONNECTICUT, U. S. A.

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PICK your frequency...

DIEHL precision resolvers and phase-shifters are available for operation at frequencies up to 2 Mc.

Operable *and accurate* at frequencies up to 2 Mc., the DIEHL line of precision resolvers and phase-shifters are right now proving their accuracy in a growing number of actual applications.

One of the secrets of their success is an ultra-flexible basic design which permits almost limitless winding variations in the same size 11 frame, tailoring each unit for optimum performance at *your* frequency.

Another is the wealth of design and manufacturing experience obtained during the four years since development of the first high frequency units in the precision manufacturing facility at DIEHL.

Not to be overlooked is the company's willingness to accept special frequency requirements rather than insisting on conformance to arbitrary "standard" values.

Take advantage of all our "trade secrets" when you specify high frequency resolvers and phase-shifters by DIEHL.

Write for complete information. 4004

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DIEHL MANUFACTURING COMPANY

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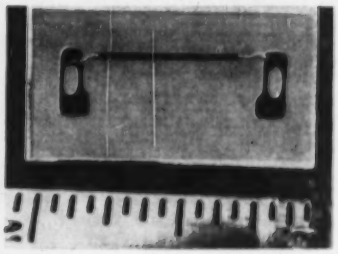
CIRCLE 112 ON READER-SERVICE CARD

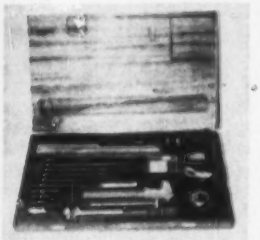
STRAIN GAGE



New ultrasensitive semiconductor strain gage Micro-Sensor, Model MS 105-350, is especially applicable to measurement of minute strain imposed upon small areas. Gage factor is approx. 130. Gage resistance is 350 ohms. Maximum operating strain is above 3000 microinch/in.—*Micro-Systems, Inc., 2925 E. Foothill Blvd., Pasadena, Calif.*

CIRCLE 250 ON READER-SERVICE CARD

METER TUBE CHECK KIT



New 27-piece check kit measures meter tube diameters and lengths, meter tap holes, orifice plate bores, outer diameters, flatness and edge sharpness.—*Daniel Orifice Fitting Co., Box 19097, Houston 24, Texas.*

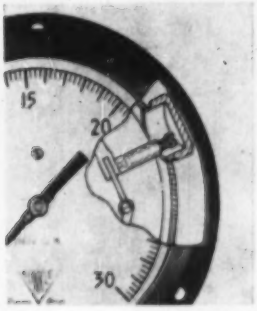
CIRCLE 251 ON READER-SERVICE CARD

RECORDING SYSTEM

New automatic, multistation data recording system acquires test and inspection data from remote locations and records it on IBM cards. Format flexibility is provided through use of plugboard incorporated in each transmitter unit. System will record and transmit data at a rate of 133 characters per sec, or one IBM card within 0.6 sec.—*Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.*

CIRCLE 252 ON READER-SERVICE CARD

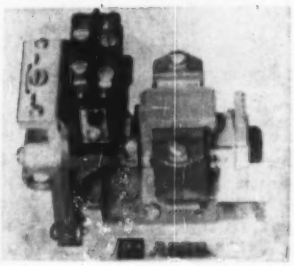
BOURDON TUBE BLEEDER



New bleeder device supplied with high-reliability and commercial processing equipment pressure gages permits complete removal of air from sealed, gage-equipped systems. It allows a gage to function with prompt response in low-pressure ranges where diaphragm spring effect must be minimized, or in high pressure ranges (to 20,000 psi) where diaphragm travel is limited. Accessible from outside gage case.—*Kunkle Valve Co.*, 121 *S. Clinton St., Fort Wayne, Ind.*

CIRCLE 253 ON READER-SERVICE CARD

PNEUMATIC TIMER



New 1-minute pneumatic timing relay sets high operating standards on applications such as machine tool and sequence control. Adjustment screw takes 7 complete turns to insure accurate adjustment over a range from 0.2 to 60 seconds (Publication LO-71). —*Cutler-Hammer*, 503 *N. 12th St., Milwaukee, Wis.*

CIRCLE 254 ON READER-SERVICE CARD

MAGNETIC SHIELDS

New Netic Co-Netic shielded enclosures permit temporary or permanent shielding of separately manufactured sub-assemblies designed to be integrated into a total package.—*Magnetic Shield Div., Perfection Mica Co.*, 1322 *N. Elston Ave., Chicago* 22, *Ill.*

CIRCLE 255 ON READER-SERVICE CARD

NEW! CUSTOM GRADE CONSOLES AT LOW STOCK PRICES!

GENCO CABINETS & PANELS

* fit your space exactly
* fit your equipment exactly
* protect costly, fragile instruments

Now consoles, instrument panels, cabinets don't have to be either expensive custom installations or cheap stock items. **GENCO** brings you the benefits of each . . . custom-made at little more than stock prices.

NEW BRUNSWICK GENERAL SHEET METAL WORKS
425 Cleveland Avenue, Highland Park, New Jersey
.....Rush my copy of new GENCO brochure.
..... Have your representative call.
Name.....
Company.....
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CIRCLE 113 ON READER-SERVICE CARD

YEAR END SUPPLIES NOW!

Check Model 2D-4 for engraving panels to 30" wide. Range: 1:1 to infinity.

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M. O. BOLTEN
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JOHN TRAVERS
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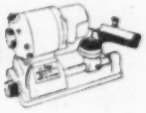
Check Copy Type-More than 80 distinct copy styles. Sizes from ¼" to 6" high. Sunk reading right or reversed. Raised for 2 or 3 dimensional engravers.

Check Cutter Grinder for sharpening your engraving cutters.



Check your cutter Supplies. High Speed Steel, Tungsten Carbide, Diamond Cutters.

A Full Line of Panto Engraving and Marking Machines

- Rotary Tables
- Copy Type Holders
- Work Holding Fixtures
- Endless Belts

TRADE MARK PANTO

Write for complete details and prices. For immediate attention write directly to manufacturer below. Ask for nearest representative.

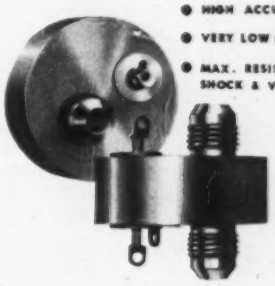
H. P. PREIS ENGRAVING MACHINE CO.
661 U. S. Highway 22, Hillside, N. J.

CIRCLE 114 ON READER-SERVICE CARD

REC's 800 SERIES, PRESSURE TRANSDUCERS

Features

- FAST RESPONSE
- HIGH ACCURACY
- VERY LOW HYSTERESIS
- MAX. RESISTANCE SHOCK & VIBRATION



Model 800C

REC's Model 800C Capacitance Type Pressure Sensor utilizes a free-edged, circular diaphragm of Ni-Span C. Full scale ranges are from 1 to 100 psi and differential or absolute pressure measurements can be made.

The 15 psi range features 100 percent overpressure, no resonances less than 2500 cps, and a pneumatic greater than .004 seconds. Maximum excitation voltage is 110 V rms and the capacity ratio change is such as to directly produce an output equal to 25 percent of this voltage.

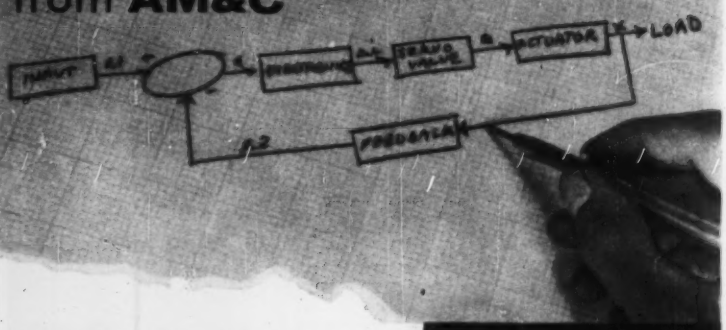
Write for Bulletin No. 36010

REC ROSEMOUNT ENGINEERING COMPANY

4900 WEST 78TH STREET, MINNEAPOLIS 24, MINNESOTA

CIRCLE 115 ON READER-SERVICE CARD

close the loop . . with ELECTRO-HYDRAULIC SERVO COMPONENTS . . from AM&C



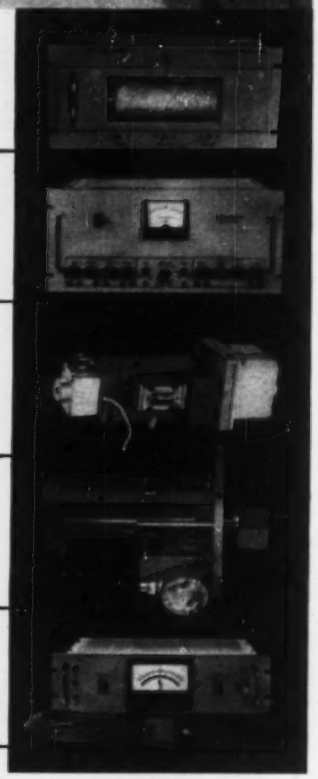
INPUT → *Model 750 Analog Programmer* — Generates a voltage corresponding to an arbitrary function drawn on graph paper: ramp, sine, square and triangular function generators . . also available.

ELECTRONICS → *Model 601 Servo Amplifier* — Provides summing, amplification and feedback circuitry for driving any electro-hydraulic servo valve. Other standard and special AC or DC amplifiers and demodulators also available.

SERVO VALVE → *Model 244 Electro-Hydraulic Servo Valve* — 0-50 gpm, 3000 psi valve designed for rugged, industrial use. Incorporates powerful, long-life *Model 104 Torque Motor*. Other servo valves available from 0-1 to 0-400 gpm and to 5000 psi system pressure.

ACTUATOR → *Model 500 Hydraulic Actuator* — Completely instrumented. Can incorporate servo valve manifold, filters, solenoids, overload protection, AC or DC feedback devices. Other linear or rotary hydraulic actuators can also be supplied.

FEEDBACK ← *Model 690 Dynamic Position Meter* — Provides feedback voltage and readout as a function of load position. Other feedback units available for sensing pressure, flow, force, velocity, attitude and other parameters.



AM & C can provide *all* of the elements for successful servo control — from the engineering and production of unique electronic, electro-hydraulic and electro-mechanical components to complete integrated system "packages" to do a specific job. If your problem involves instrumentation or automatic control of position, speed, pressure, flow, or force, our engineers can assist you. Telephone or write:

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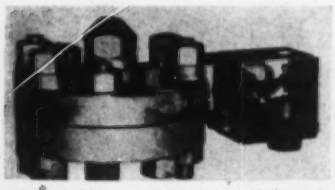
CIRCLE 116 ON READER-SERVICE CARD

LEVEL PILOT



New differential-level pilot valve operates on the difference between two columns of liquid, usually between a constant reference head and a variable head. As level rises in variable column, pilot valve opens and releases air pressure from top diaphragm motor valve, allowing the discharge of liquid from variable column. When level in this column falls to a pre-determined level, valve again closes and cycle repeats.—*Besler Corp., 4053 Harlan St., Emeryville, Oakland 8, Calif.*

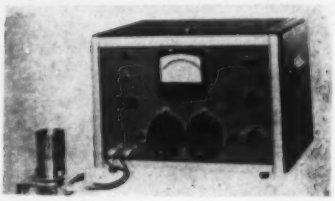
CIRCLE 256 ON READER-SERVICE CARD

PRESSURE DROP INDICATOR

New Model 91414 indicators for monitoring pressure drop across hydraulic filters are for use in hydraulic test stands and high-speed servo systems. Calibration is from 0 to 60 psid and meters may be employed in systems rated up to 3000 psi. Magnetic coupling to the meter movement eliminates moving seals.—*Boonshaft and Fuchs Inc., Hatboro Industrial Park, Hatboro, Pa.*

CIRCLE 257 ON READER-SERVICE CARD

MOISTURE ANALYZER



New industrial moisture analyzer Model HFR-4E uses a new method of moisture determination by means of radio-frequency power absorption. Features: 0-80% moisture content range; 0.001-0.5% accuracy; instantaneous and nondestructive testing.—*Boonton Polytechnic Co., Inc., Box 125, Boonton, N. J.*

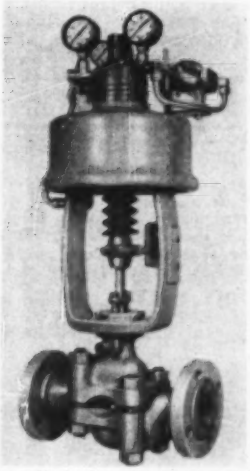
CIRCLE 258 ON READER-SERVICE CARD

750° LOAD CELL

New load cell measures both tension and compression; can be used up to 750°F. Offered in ranges from 5000 to 50,000 lbs. with ¼% accuracy.—*Micro-Test, Inc.*, 1718 21*st St., Santa Monica, Calif.*

CIRCLE 259 ON READER-SERVICE CARD

SPLIT-BODY VALVES



New split-body valves are available in straight-through, angle and corner types with fixed or separable flange construction, allow intermix of diaphragm and cylinder actuators with split bodies and globe bodies to match specific applications economically.—*Valve Div., Minneapolis-Honeywell, Fort Washington, Pa.*

CIRCLE 260 ON READER-SERVICE CARD

VOLTMETERS-RATIOMETERS

New 4-digit V34A and 5-digit V35A digital voltmeters-ratiometers feature more versatile print control to permit printing varying input signals, isolation of signal ground from chassis ground for signals which are floating up to 300v above chassis ground potential, remote ac-dc switchover, "no-needless-nines" logic that eliminates cycling of stepping switches through all positions in each decade when a measurement is made.—*Non-Linear Systems, Inc., Del Mar, Calif.*

CIRCLE 261 ON READER-SERVICE CARD

LOW BUDGET...

GOW-MAC CHROMATOGRAPHY COMPONENTS

...FOR FAST DELIVERY

MINIMIZE VPC DETECTOR DOWN TIME!

CUSTOMER FIELD SERVICE

FILAMENTS IN MATCHED PAIRS
(A) 2-inch leads
(B) 12-inch leads
(Minimum order 5 pairs)

HARNESSES—
Two matched pairs, improved wiring in balanced bridge with terminal panel, 12-inch electrical leads and four tube nuts.

UP GRADE EARLY MODELS!

FACTORY REBUILDING OF YOUR THERMAL CONDUCTIVITY DETECTORS

Detectors cleaned, re-filamented and bench-tested on specified carrier (0-5 mv. recorder or 0-1 mv. recorder as required).

BIG SIGNAL LOW NOISE RELIABLE!

PANCAKE POWER SUPPLIES

Solid state, 20 volts at 500 milliamperes. Helipot attenuator or decade stepping switch. Quick, easy hook-up.

ALSO AVAILABLE—

- Thermal Conductivity Cells for Gas Analysis
- Micro-Cell for use with ⅛" Packed Columns, VPC
- Gas Blenders for Automatic Mixing of Gases
- Temperature Regulated Cells
- Gas Density Detectors for VPC
- Portable and Panel Instruments

CALL OR WRITE for literature, mentioning type of equipment in which you are interested. Address inquiries to Dept. IA.

GOW-MAC INSTRUMENT COMPANY

100 KINGS ROAD, MADISON, N. J., U. S. A. • Telephone: FRontier 7-3450

GAS ANALYSIS BY THERMAL CONDUCTIVITY SINCE 1935

CIRCLE 117 ON READER-SERVICE CARD

HARDNESS TESTING

SCLEROSCOPE FOR TESTING THE HARDNESS OF METALS. PIONEER AMERICAN HARDNESS STANDARD. OVER 40,000 IN USE. (ASTM A427)

DUROMETER **FOR TESTING THE HARDNESS OF RUBBER & RUBBER-LIKE MATERIALS (ASTM D676) (ASTM D1484) (ASTM D1706)**

SHORE INSTRUMENT & MFG. CO., INC.
90-35 VAN WYCK EXP.
JAMAICA 35, N. Y.

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MACHINE-DIVIDED SCALES

Made with latest SIP Swiss Automatic Dividing Machines

LINEAR
Accuracy to ±5 microns (0.0002")

CIRCULAR
Accuracy to ±5 seconds

Any scale pattern—Any line width
Any material

FINE MACHINE ENGRAVING

Scales, Dials, Drums, Rods, Panels

ACCURATELY ETCHED RETICLES

Made in any specified pattern and dimensions

PRECISION MACHINE-RULED MASTERS

For printed circuits, i.e., commutators, switches, and general circuitry

L. C. RENICK CO.

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CIRCLE 119 ON READER-SERVICE CARD

POST
ELECTRONIC
PRODUCTS
Model K-1A — When the light beam is not interrupted — output relay is energized.
Model K-1B — When the light beam is interrupted — output relay is energized.
Model K-2 — Photo-electric timer with adjustable (.05-10 sec.) output relay closure.
Model K-3 — Photo-electric stop-motion and jam detector:
K-3R — When light beam is interrupted for the present time delay-output relay is energized.
K-3F — When light beam interruptions cease for a preset time delay-output relay is energized.
Decitron
POST ELECTRONIC PRODUCTS
Division of Reid Brothers Company, Inc.
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Ultra-fast Optics

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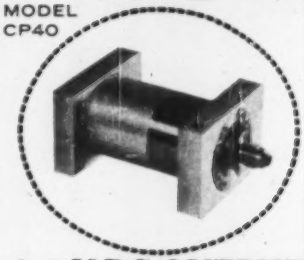
PACE

MODEL CP40



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PRESSURE
TRANSDUCER

Ranges: 5 to 1,500 psi — Gage, Differential or Absolute—Accepts corrosive fluids, both sides.

Insensitive to Shock and Vibration.

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CIRCLE 122 ON READER-SERVICE CARD

I&CS NEW LITERATURE

CONTROL SYSTEMS

OPEN HEARTH SYSTEMS. 16-page Bulletin MSA-189 describes adaptation of automatic control systems to 12 open hearth furnaces. Also listed are 5 steps to achieve full automation of open hearth process.—Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa.

CIRCLE 262 ON READER-SERVICE CARD

PROCESS CONTROL. 8-page Bulletin 10 describes Microsen closed-loop, all-electronic process control systems, capacitance-actuated level detection and control instruments, and Vibraswitch malfunction detectors. Also 2-page application report describes capacitance-probe instrumentation for continuous, automatic monitoring of hot gravel levels at an asphalt plant.—Aeronautical and Instrument Div., Robertshaw-Fulton Controls Co., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

CIRCLE 263 ON READER-SERVICE CARD

VALVES

VALVES AND CONTROLS. 4-page Circular VS-51 describes 2, 3 and 4 Way solenoid valves, emergency control systems, remote control switches and systems, contactors, relays and solenoids.—Automatic Switch Co., Florham Park, N. J.

CIRCLE 264 ON READER-SERVICE CARD

SHUT-OFF VALVES. 8-page Bulletin 8100-60 describes models, accessories and applications of Series 800 manual reset, safety shut-off valves.—Maxon Premix Burner Co., Muncie, Ind.

CIRCLE 265 ON READER-SERVICE CARD

VALVES FOR GASES AND LIQUIDS. 2-page bulletin describes Series 400 valve featuring positive sealing for service up to 12,000 psi; 2-page Bulletin 12 describes dehydrators and air purifiers for instruments and components and for cabinets.—Robbins Aviation, Inc., 2350 E. 38th St., Los Angeles 58, Calif.

CIRCLE 266 ON READER-SERVICE CARD

TEMPERATURE

THERMOWELLS AND DRYERS. 4-page Bulletin 304 and 2-page Bulletin TT-307 describe selection of Thermowells and Econo-wells. Two 2-page bulletins describe dessiccant dryers: Bulletin A 309, Type A heat-reactivated; Bulletin AB 310, Type AB blower.—Trinity Equipment Corp., Cortland, N. Y.

CIRCLE 267 ON READER-SERVICE CARD

TEMPERATURE CONTROL. 4-page Bulletin 109 describes Model LD-1S indicating differential expansion type temperature control for electric operation.—Burling Instrument Co., 16 River Rd., Chatham, N. J.

CIRCLE 268 ON READER-SERVICE CARD

THERMAL SWITCHES. 8-page brochure describes 11 bimetal thermal switches, contains a discussion of the bimetal principle, and gives detailed technical information on applications specs, standard variations and modifications.—Control Products, Inc., 280 Ridgedale Ave., Hanover, N. J.

CIRCLE 269 ON READER-SERVICE CARD

THERMOCOUPLE HARNESSES. 2-page Bulletin 202 describes thermocouple harnesses and extension leads designed for high temperature and standard applications. Includes 5 harness assemblies.—Harco Laboratories, Inc., 77 Olive St., New Haven, Conn.

CIRCLE 270 ON READER-SERVICE CARD

PYROMETERS. 4-page Bulletin TB 1372 describes industrial infrared radiation pyrometers Models 1371 and 1372 for permanent installation or portable use.—Servo Corp. of America, 111 New South Rd., Hicksville, L. I., N. Y.

CIRCLE 271 ON READER-SERVICE CARD

THERMOCOUPLE SELECTORS. 4-page catalog described designs and uses of compact multi-point thermocouple selector switches.—Thermo Electric Co., Inc., Saddle Brook, N. J.

CIRCLE 272 ON READER-SERVICE CARD

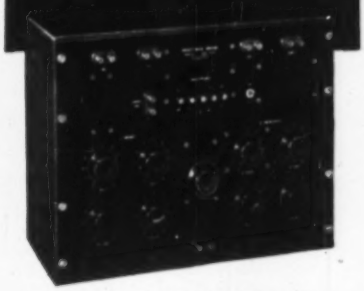
PRECISION MEASUREMENT. 8-page pocket-size condensed catalog describes precision instruments for measurement of temperature, pressure, level, and flow.—Trans-Sonics, Inc., Box 328, Lexington 73, Mass.

CIRCLE 273 ON READER-SERVICE CARD

SENSING DEVICE. 2-page Bulletin RI-1825, Supplement D, describes Wire in Tube leakproof device for detection and control of process variables (level, temp., flow and pressure).—Yarnall-Waring Co., Chestnut Hill, Phila. 18, Pa.

CIRCLE 274 ON READER-SERVICE CARD

FOR PRECISION LABORATORY OR PRODUCTION TESTING



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ACCESSORIES AVAILABLE:
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Send for NEW 48 page transformer catalog. Also ask for complete laboratory test instrument catalog.

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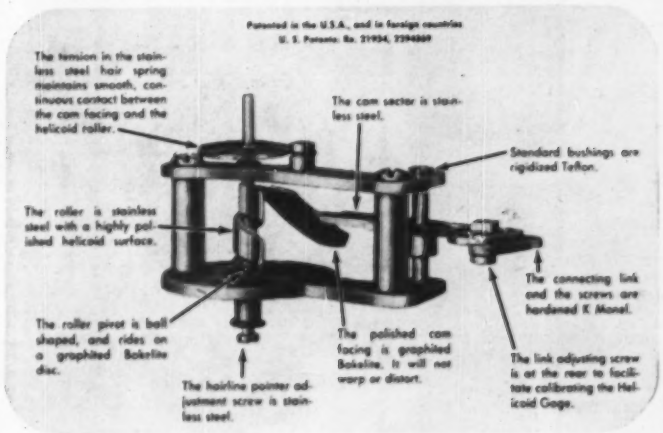
CIRCLE 123 ON READER-SERVICE CARD

ACCO Helicoid Gage U.S.A.


Patented in the U.S.A., and in foreign countries
U. S. Patents: Re. 21934, 2394869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides... *Sustained Accuracy... on the toughest jobs*

• Helicoid Gages have no gears, no teeth, reducing wear to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Helicoid Gages have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy, while conventional geared gages became useless after 500,000 cycles.

Helicoid Gages give *sustained* accuracy even when subjected to violent pressure pulsations or mechanical vibrations. Pointer can be set externally, without removing glass, and cannot be jarred out of position. Dial faces are easy to read, won't corrode or chip. A full range of Helicoid Gages is available for any application. Next time, specify Helicoid—the gage that *stays* accurate.

Bourdon Tubes won't Stretch, Leak, or Crack

Helicoid Bourdon tubes are made from seamless tubing, and are designed for maximum torque and minimum stress. At the factory, each tube is individually tested, overpressured, and stress relieved. Four materials—alloy steel, K Monel, stainless steel, and phosphor bronze—are available to meet applications ranging from tap water to almost any acid.

NEW! Solid-Front Safety Case Gives Added Protection

The new Helicoid solid-front case diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming, though not detaching, the back cover plate. Helicoid Gages are also available in phenol, acaloy flanged, acaloy flangeless, polished flangeless, round flush, polished flush ring, and square flush cases.

WRITE for details **Ask for Catalog DH-65**

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ACCO

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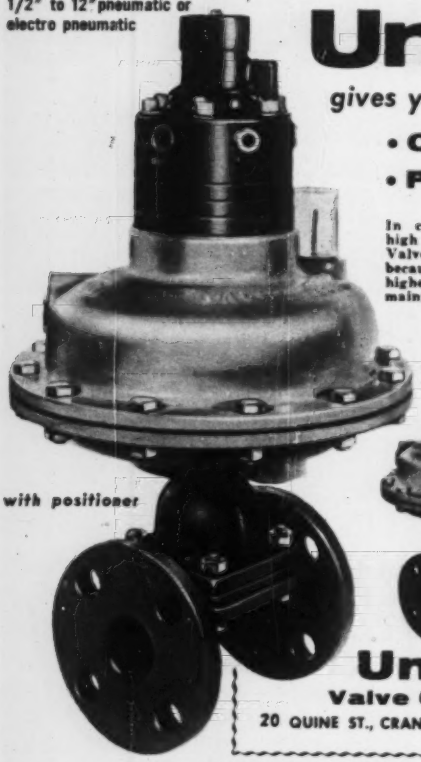
Uniflow Springless type 500 air to open – air to close – 1/2" to 12" pneumatic or electro pneumatic



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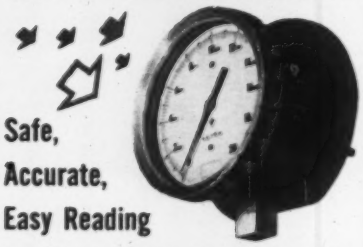
CIRCLE 126 ON READER-SERVICE CARD

The ASTRAGAUGE



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For Pressures to 100,000 p.s.i.g.

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Write for complete data and prices.

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HATBORO, PA., OSborne 5-1652

CIRCLE 127 ON READER-SERVICE CARD

TURBINE FLOWMETER. 4-page Bulletin D-225 describes and illustrates Potter Micro-Meter Series 4000, capable of measuring extremely low flow rates for such applications as pilot plants, laboratories, and metering of additives in minute quantities with a repeatability of ±¼% of reading. Sizing chart indicates meter sizes required for various ranges from 0.004 to 0.6 gpm.—Potter Aeronautical Corp., Route 22, Union, N. J.

CIRCLE 275 ON READER-SERVICE CARD

PRESSURE, WEIGHT

PRESSURE INSTRUMENTS. 2-page Bulletin 40 covers pressure measuring mechanisms, indicators, recorders, and transmitting devices.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

CIRCLE 276 ON READER-SERVICE CARD

PRESSURE REGULATORS. Two 8-page bulletins (130 and 131) detail Reliance Type CBV Series 100 and 200 pressure regulators and Series 300 low-pressure regulators.—American Meter Co., 920 Payne Ave., Erie Pa.

CIRCLE 277 ON READER-SERVICE CARD

STRAIN GAGE AND CALIBRATOR. 2-page Product Data Sheet 4325 describes Strainline photoelastic strain gage; 4-page Product Data Sheet 4504 describes SR-4 portable, precision calibration kit.—Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., Waltham, Mass.

CIRCLE 278 ON READER-SERVICE CARD

PRESSURE, ACCELERATION. 2-page Bulletin 4202 describes Type 4-202 miniature (Approx. 1-inch cubed) temperature-compensated strain gage accelerometer; 2-page Bulletin 4326, Type 4-326 strain gage pressure transducer capable to 10,000 psi; 2-page Bulletin 1156, miniature electromanometer system consisting of 2 components, Type 4-333 precision pressure balance and Type 1-156 servoamplifier.—Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 279 ON READER-SERVICE CARD

BATCH WEIGHING SYSTEMS. 20-page Bulletin B-100 contains information on 6 weighing systems. Applications range from low-cost, short-run installations in which formula is frequently varied, to complicated production batch weighing runs.—Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 280 ON READER-SERVICE CARD

TIME, SPEED

STOPWATCHES. 16-page stopwatch selection guide describes 100 different precision timing instruments for production analysts and engineers in design, testing and control.—Heuer Timer Corp., 441 Lexington Ave., New York 17, N. Y.

CIRCLE 281 ON READER-SERVICE CARD

TIME CONTROL SYSTEMS. Folder contains ten 2-page specification sheets on time control systems, primary and secondary frequency standards, and programmers.—Designers for Industry, Inc., Time Control Systems Div., 4241 Fulton Parkway, Cleveland 9, Ohio.

CIRCLE 282 ON READER-SERVICE CARD

I&CS NEW LITERATURE

SPEED CONTROLLER. 4-page Bulletin V-1 describes adjustable electronic speed control using thyratron phase-shifting grid control.—ECI Mfg. Div. of Electronic Controls Inc., 85 Magee Ave., Stamford, Conn.

CIRCLE 283 ON READER-SERVICE CARD

TACHOMETERS. 12-page Catalog 62 contains pictures and descriptions of 19 tachometer types, and types of flexible shafts, drives, and drive arrangements.—Jones Motrola Corp., 432 Fairfield Ave., Stamford, Conn.

CIRCLE 284 ON READER-SERVICE CARD

DIGITAL SPEED MEASUREMENT. 6-page Bulletin 2000, "Digital Speed Measurement Systems," illustrates instrumentation designed to provide accurate and trouble-free measuring, indicating or recording of rotative motion. Spec tables are coordinated with recommendations for application, mounting and coupling of each model. —Meriam Instrument Co., 10920 Madison Ave., Cleveland 2, Ohio.

CIRCLE 285 ON READER-SERVICE CARD

ANALYTICAL

RECORDING SPECTROPHOTOMETER. 12-page Bulletin GEZ-3031 details features and operating principles of GE recording spectrophotometer for measuring colors of materials, automatic tristimulus integrator, and other accessories. Includes cost-saving application information, product, specs and ordering information.—General Electric Co., Schenectady 5, N. Y.

CIRCLE 286 ON READER-SERVICE CARD

MOISTURE ANALYZER. 4-page Bulletin 1001 and three 2-page data sheets (1010, 1020, 1050) describe Model W electrolytic moisture analyzer-recorder, portable Type NEP-PL or NEP-BA, vacum Type VAC, and high pressure Type HP.—Manufacturers Engineering & Equipment Corp., York and Sunset Lane, Hatboro, Pa.

CIRCLE 287 ON READER-SERVICE CARD

COMPOSITION ANALYSIS. 12-page Bulletin CA-860 "AccuRay Continuous On-Stream Composition Analysis," describes principles of continuous, non-contacting measurement of fluids by using radioisotopes to detect changes in specific gravity, etc.—Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus 2, Ohio.

CIRCLE 288 ON READER-SERVICE CARD

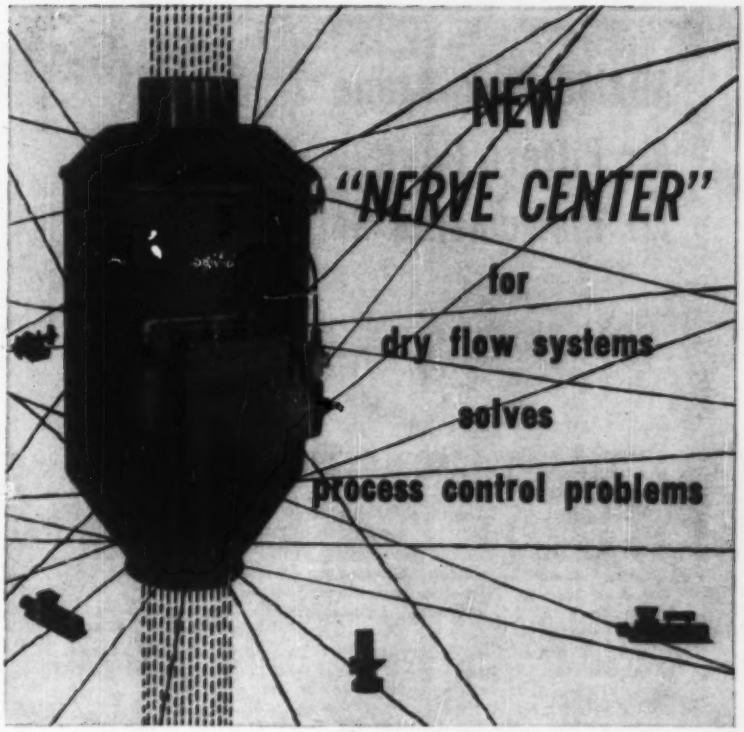
GAS DETECTOR. 2-page sheet describes J-W Sniffer, Model G, combustible gas indicator.—Johnson-Williams, Inc., Palo Alto, Calif.

CIRCLE 289 ON READER-SERVICE CARD

DATA HANDLING

ALGEBRAIC COMPILER. 32-page manual describes principles and operational characteristics of Bendix G-15 algebraic compiler. Complete typical ALGO program included. 4-page Report 13 describes use of G-15 by Illinois accounting firm.—Bendix Computer Div., Bendix Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.

CIRCLE 290 ON READER-SERVICE CARD



The new W&T Massometer® senses flow in closed systems. It measures dry, free-flowing materials and translates the results into a 3-15 psi signal. The unit can be used to indicate or record. It also controls proportional blending . . . helps solve problems in all kinds of control situations.

And the Massometer does all this without breaks in your closed system. Air-tight construction means a flow-sensing unit that seals dust in . . . seals contamination out. It is compact and easily installed, fits neatly into the line. Stainless steel for parts exposed to the flow stream and dust-tight motor casing assure years of maintenance-free service.

The Massometer is calibrated with any maximum output between 40 and 200 lbs. per minute. Maximum volumetric capacity is 6 cubic feet per minute. Repeatability within ±0.2% of full scale assures stable performance.

By generating a signal proportional to flow, the W&T Massometer brings a new look to ratio control. Its versatility means more accurate batch processing, or helps create continuous processing in new or existing systems.

For information, write Dept. M-50.48

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CIRCLE 128 ON READER-SERVICE CARD

ADAMS Poro-Stone Air Filters Keep Air Instruments Safe

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To relieve the load on the filter element, larger particles and droplets are knocked out by centrifugal separation immediately upon entering the filter housing. Non-absorbent, chemically inert Poro-Stone stays open for maximum efficiency. Occasional rinsing in solvent is all that's needed.

See how Adams Poro-Stone Air Filters can give longer life to your air instruments. Bulletin 117 is complete with design diagrams, specifying tables and application data. Write for your copy today!

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on available measurement and control devices and systems—yours for the looking—in the

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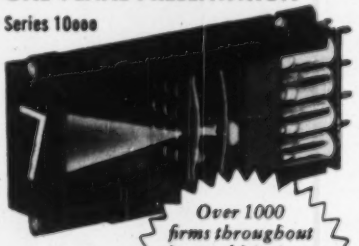

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CIRCLE 131 ON READER-SERVICE CARD

I&CS NEW LITERATURE

DATA PROCESSING SYSTEM. 8-page Bulletin S-4017-A outlines a step-by-step program of "Building Block" process control using Beckman 123 data processing system.—Beckman Scientific and Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.

CIRCLE 291 ON READER-SERVICE CARD

PHASE EQUILIBRIUM. 7-page Form 80-105-009 describes solutions to multi-component phase equilibrium problems with DYSTAC analog computer.—Computer Systems, Inc., Culver Rd., Monmouth Junction, N. J.

CIRCLE 292 ON READER-SERVICE CARD

DIGITAL SYSTEMS. 4-page folder outlines digital building blocks, test units, digital systems and accessories.—inverters, diode OR's, clocks, etc.—Digital Equipment Corp., Maynard, Mass.

CIRCLE 293 ON READER-SERVICE CARD

MESSAGE DISPLAYER. 4-page Bulletin 1003 explains operation and features of Type SD-11 miniature spherical optic displays which can display numbers or words on screens.—Burroughs Corp., Electronic Tube Div., Plainfield, N. J.

CIRCLE 294 ON READER-SERVICE CARD

DATA TRANSMITTER. 4-page brochure details use of "Dial-o-verter" System, which when used with the Bell System Data-Phone 200, permits use of regular telephone network for sending and receiving data at high speed to and from any number of remote locations.—Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.

CIRCLE 295 ON READER-SERVICE CARD

DIGITAL TAPE TRANSPORT. 2-page sheet describes M3000 digital tape transport which features higher usable tape speed than that available with existing on-line transports.—Midwestern Instruments, Inc., 41st & Sheridan Rd., Box 7186, Tulsa 18, Okla.

CIRCLE 296 ON READER-SERVICE CARD

TABLE MODEL COMPUTER. 6-page folder describes pb 250, which has the lowest component count of any high-speed general purpose digital computer and operates at speeds comparable to those of large size computers.—Packard-Bell Computer, 1905 Armacost Ave., Los Angeles 25, Calif.

CIRCLE 297 ON READER-SERVICE CARD

MAGNETIC TAPES. 6 product bulletins, each on a specific tape (computer, telemetering, numerical control, etc.), and a 4-page bulletin tabulating physical and magnetic characteristics of Soundcraft tapes are available.—Reeves Soundcraft Corp., Great Pasture Rd., Danbury, Conn.

CIRCLE 298 ON READER-SERVICE CARD

TELEMETERING SYSTEM. 2-page sheet describes Model T-108 tone telemetering system, a totally solid state, high temperature, ruggedized tone generating system capable of operation in associated FM-FM telemetering systems.—Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif.

CIRCLE 299 ON READER-SERVICE CARD

DEMODULATOR/PHASE DETECTOR. 2-page sheet describes Model 1806 electronic demodulator and phase detector with applications in data transmission, error sensing, and servomechanisms.—Varco Mfg. Co., Inc., 2201 Walnut St., Garland, Tex.

CIRCLE 300 ON READER-SERVICE CARD

ELECTRONIC CALCULATOR. 16-page IBM 609 Calculator Model B1 Bulletin tells how IBM 609 expands applications of IBM 604 and similar unit record calculators.—International Business Machines Corp., Data Processing Div., 590 Madison Ave., New York 23, N. Y.

CIRCLE 301 ON READER-SERVICE CARD

DATA RECORDER. 3-page Bulletin OA-0882 featurse Model 400 Develocorder which records multichannel low-frequency data on 16-mm film. Film is automatically processed within unit as soon as exposed. Data are magnified 10 times and displayed on viewscreen within 10 minutes.—Geotechnical Corp., 3401 Shiloh Rd., Garland, Texas.

CIRCLE 302 ON READER-SERVICE CARD

DATA HANDLING EQUIPMENT. 4-page short form catalog lists magnetic tape search and control systems, time code generators, data handling equipment, etc.—Electronic Engineering Co., 1601 E. Chestnut Ave., Santa Ana, Calif.

CIRCLE 303 ON READER-SERVICE CARD

DATA PROCESSING. 28-page booklet illustrates and explains diversified applications—letter writing, purchasing, manufacturing control, and bank check coding. Also building-block concept whereby various auxiliary input-output units may be connected to a Flexowriter to provide varying degrees of automation.—Friden, Inc., Promotion Planning Dept., 1 Leighton Ave., Rochester 2, N. Y.

CIRCLE 304 ON READER-SERVICE CARD

SERVOMATIC TRANSDUCER. 6-page Bulletin 98375 describes Transcope 710T, 711T, 712T servomatic transducers designed for use with computers and data loggers.—Taylor Instrument Companies, Rochester 1, N. Y.

CIRCLE 305 ON READER-SERVICE CARD

RECORDERS, MONITORS

RECORDING SYSTEM. 4-page brochure describes Brush Mark II portable direct-writing recorders including both electric and ink writing types.—Brush Instruments, Div. of Clevite Corp., 37th & Perkins, Cleveland 14, Ohio.

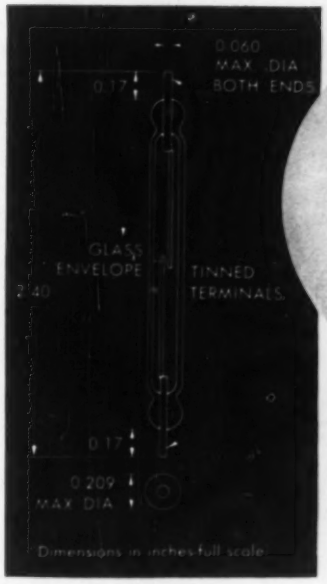
CIRCLE 306 ON READER-SERVICE CARD

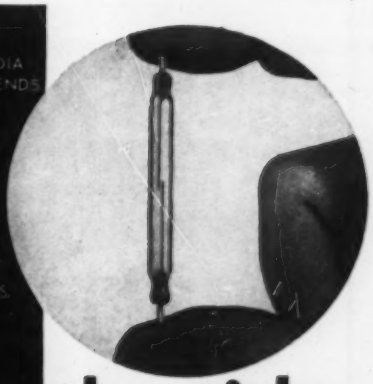
PORTABLE OSCILLOGRAPH. 4-page Bulletin 5124 describes operation of low-cost, portable easy-load recording 5-124 oscillograph.—Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 307 ON READER-SERVICE CARD

RECORDER AND INTEGRATOR. Two 2-page bulletins (418 and 419) cover strip-chart recorder for flow, pressure and temp measurement; and chart integrator for interpretation of strip charts and conventional round charts. —American Meter Co., 920 Payne Ave., Erie, Pa.

CIRCLE 308 ON READER-SERVICE CARD





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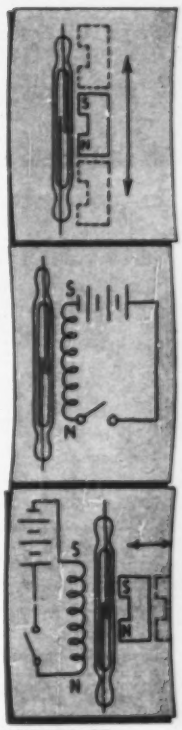
Whenever you need faster, more positive response . . . where extreme sensitivity is a must . . . where light weight is important . . . investigate the Revere GLASWITCH. Write today for complete specifications.



CHARACTERISTICS:

Type—Single pole single throw—normally open—snap action
Enclosure—Hermetically sealed glass tube containing inert dry atmosphere
Operating Time—1 millisecond
Operating Rate—Up to 400 cycles per second
Contact Surfaces—Electroplated Rhodium
Contact Resistance (measured terminal-to-terminal)
Closed Circuit—0.050 ohms maximum
Open Circuit—500,000 megohms minimum
Contact Ratings
DC—Up to 1 ampere
AC—Up to 25 watts depending on application
Reliability and Life
No Load—Billions of operations
Rated Loads—No failures to open or close in first 100,000 cycles
Ambient Temperature Range: —320°F to +300°F

METHODS OF ACTUATION:

A moving permanent magnet or controlled external electromagnetic field are all you need . . . and the sky's the limit on imagination!

*Trade Mark

neptune

REVERE CORPORATION OF AMERICA / *Wallingford, Conn.*

One of Neptune Meter Company's Electronic subsidiaries

CIRCLE 132 ON READER-SERVICE CARD

New Line of corrosion-resistant needle valves

MARSH Needle Valves in 316 STAINLESS STEEL

Throttle flow and throttle corrosion with this new valve series that gives you the superlative construction of Marsh Needle Valves with the corrosion-resistance of 316 stainless steel.

Here is a valve that gives you precision throttling and tight closure on pressures from a few pounds to 6000 psi. Wide temperature range, too—from minus 100°F. to plus 500°F. —as a result of the Marsh "Marpak" packing system utilizing precision moulded Teflon.

New 316 stainless series (series 1936) is identified by blue handle. Sizes from ⅛" to 1"; globe, angle, and panel mounted patterns.

Marsh Needle Valves are also available in 416 stainless steel (identified by green handles) and in alloy steel (identified by yellow handles).

Ask for bulletin NV-3

MARSH INSTRUMENT COMPANY, Dept. 42, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd., 8687 163rd St., Edmonton, Alberta
Houston Branch Plant, 1171 Rothwell St., Sect. 15, Houston, Texas

CIRCLE 133 ON READER-SERVICE CARD

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CIRCLES & SPECIAL SHAPES

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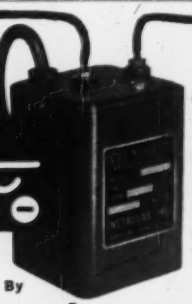

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POTENTIOMETERS
• CONTROLLERS • INDICATORS
• RECORDERS

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Phone BA 3-2241

Outstanding FEATURES
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- **Reliable** construction... from quality components, long, trouble-free service
- **A Precise** voltage regulator . . . max. ±.04% for ±20% voltage variation
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- **No Tubes** to replace

CIRCLE 135 ON READER-SERVICE CARD

IMPULSE RECORDER. 4-page spec sheet features modular helixgraphic recording system, Model 305 GPL.—Alden Electronic & Impulse Recording Equipment Co., Inc., Westboro, Mass.
CIRCLE 309 ON READER-SERVICE CARD

STRIP-CHART RECORDER. 2-page Bulletin 774 lists operating features and specs of potentiometric strip-chart recorder.—Beckman Scientific and Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.
CIRCLE 310 ON READER-SERVICE CARD

TRANSDUCER AND RECORDER. are featured in 2-bulletins: 2-page Bulletin DP-101 describes passive electronic transducer for measuring differential pressure, level, flow; 4-page Bulletin R-301 describes transistorized mini potentiometer/receiver recorder. —DeVar Systems, Inc., 494 Glenbrook Rd., Glenbrook, Conn.
CIRCLE 311 ON READER-SERVICE CARD

TAPE RECORDER. 6-page Bulletin 59 offers illustrations, specs, and a die-cut replica of new ᵴ instrumentation tape recorder which doubles bandwith and recording time previously obtainable from conventional equipment.—Precision Instrument Co., 1011 Commercial St., San Carlos, Calif.
CIRCLE 312 ON READER-SERVICE CARD

FACSIMILE RECORDERS. 8-page brochure describes Weatherfax Model RJ continuous facsimile recorder for weather maps, charts and other pictorial data sent by radio. Can be used by Air Force and Naval bases and weather forecasting services to record weather data transmitted continuously by Weather Central in Washington, D. C.—Westrex Communications Equipment Dept., 540 W. 58th St., New York 19, N. Y.
CIRCLE 313 ON READER-SERVICE CARD

MONITOR ALARM. 4-page brochure describes Signal Sentry monitor alarm system accurate to 0.1% for 30 stations. Also portable, self-checking, 6-months maintenance-free operation.—Communications Control Corp., 14707 Keswick St., Van Nuys, Calif.
CIRCLE 314 ON READER-SERVICE CARD

GAGING, TESTING

TEST SETS. 12-page Book 1 features 12 short reports on test sets, transducers, densitometers, etc.—Servomechanisms, Inc., 200 Aviation Blvd., El Segundo, Calif.
CIRCLE 315 ON READER-SERVICE CARD

IMPEDANCE COMPARATOR. 2-page sheet describes Model 60 impedance comparator for comparing resistors, condensers and inductors by indicating percentage deviation from a standard.—Industrial Test Equipment Co., 55 E. 11th St., New York 3, N. Y.
CIRCLE 316 ON READER-SERVICE CARD

THICKNESS TESTING. 10-page brochure, Modern Thickness Testing, describes nondestructible methods employed for measuring thicknesses of organic and non-magnetic metal coatings (including phosphate) on iron and steel.—Twin City Testing Corp., 533 S. Niagara St., Tonawanda, N. Y.
CIRCLE 317 ON READER-SERVICE CARD

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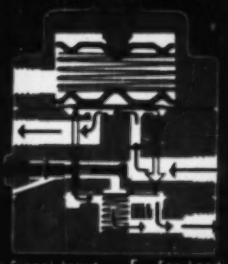
pneumatic
CONTROL
automatic or manual
trip or reset = "MITE"

The MITE is a snap-acting adjustable pneumatic switch and/or relay.
Venting, lock-up and switching are accomplished as follows:



A – Air Signal Input
B – Signal Output (Lock-up on trip)
C – Signal Output (Vent on trip)
D – Remote Pneumatic Trip
E – Remote Pneumatic Reset
F – For Loading to Nullify E
G – TRIP TO OPEN To H
H – Common to G and I
I – TRIP TO CLOSE

Get complete details on the MITE ... catalog.

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COMPANY, INC.
86 TUPELO STREET
BRISTOL, RHODE ISLAND
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VALVES AND CONTROLS FOR THE COMMUNICATIONS, PROCESS, AIRCRAFT AND MARINE INDUSTRIES

CIRCLE 136 ON READER-SERVICE CARD

IGS NEW LITERATURE

TUBING

INSTRUMENTATION TUBING. 12-page Bulletin 380, "Specialty Tubing for Industrial Instrumentation," describes tubing developed for particular end uses demanded by increased accuracy and reliability of advanced instrument designs. Applications, required characteristics, materials, size range, length range, tolerances, and tempers are given.—Superior Tube Co., Norristown, Pa.

CIRCLE 318 ON READER-SERVICE CARD

ARMORED MULTITUBE. 12-page Bulletin 960 describes spirally cabled tubes for instrument and control systems, types of tubing, protective interlocked metallic armor, types of corrosion-resistant sheaths, and installation instructions.—Crescent Insulated Wire & Cable Co., Trenton 5, N. J.

CIRCLE 319 ON READER-SERVICE CARD

ELECTRICAL, ELECTRONIC INSTRUMENTS

TRANSFER VOLT-AMMETERS. 6-page data file gives specs of transfer volt-ammeters in 3 models for measuring dc, ac, and voltage at frequencies up to 50,000 cps with an accuracy of 0.05%. Also available, 24-page "This Is the Story of Engelhard Industries, Inc."—Engelhard Industries, Inc., 75 Austin St., Newark 2, N. J.

CIRCLE 320 ON READER-SERVICE CARD

MICRO- AND MILLIAMMETERS. 2-page sheet lists typical applications of d-c recording microammeters and milliammeters.—Esterline-Angus Co., Box 596, Indianapolis 6, Ind.

CIRCLE 321 ON READER-SERVICE CARD

FREQUENCY MEASUREMENT. 5-page Application Note 2 presents detailed methods of measuring frequency from VHF up to and above 18 KMC with transfer oscillator/counter techniques.—Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

CIRCLE 322 ON READER-SERVICE CARD

HIGH VOLTAGE RECTIFIER. 16-page manual, SR-370, provides specs, electrical principle and operating data on new series of superpower, high voltage rectifier columns capable of new highs in power handling capacity (from 10,000 to 120,000 v with current output ranging from 1 to 50 amps).—International Rectifier Corp., El Segundo, Calif.

CIRCLE 323 ON READER-SERVICE CARD

VOLTMETERS. 10-page folder, "Pocket Guide to the Proper Selection of Digital Measuring Instruments"; 6-page bulletin on Model V44 all-electronic digital voltmeter; and 4-page bulletin on Model 484 industrial digital voltmeter are available.—Non-Linear Systems, Inc., Del Mar, Calif.

CIRCLE 324 ON READER-SERVICE CARD

VARIABLE TRANSFORMERS. 4-page leaflet features Series 116-216, 117-217, 126-226 motor-driven Powerstat variable transformers.—Superior Electric Co., Bristol, Conn.

CIRCLE 325 ON READER-SERVICE CARD

What!! a universal counter-timer with in-line NIXIE readout for only $895.00?

Yes, sir! It's true. And the new Erie Model 725 has all the quality features usually found in instruments costing up to 50% more.

Model 725

Model 725 accurately counts cyclic or random electrical events and precisely measures frequency, period and time intervals. NIXIE readout is available in 5 or 6 decades. Major components are independent modules for easy maintenance. An internal SELF-TEST automatically checks counter operation.

Incorporating quality, flexibility, performance and PRICE, the Model 725 is your best instrument for production or laboratory use. Why not send for complete technical literature today?

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CIRCLE 137 ON READER-SERVICE CARD

ICS SEARCHLITE SECTION

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For Precise and Rapid Measurements of
SHAFT SPEEDS CUTTING SPEEDS SURFACE SPEEDS

- Magnetic Design Steady readings accurate to ±0.5%
- Self-Powered Needs no battery.
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Fixed Set Thermostats

ANY SIZE, ANGLE OR USE
SETTING RANGE: —35°C to 370°C
SET SENSITIVITY: ±.01°C

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CIRCLE 139 ON READER-SERVICE CARD

Model HT-12 Four-Range Tachometer

Centrifugal tachometer that measures revolutions per minute and surface speeds.

TOTAL RANGE: 90-12,000 RPM
1st — 90-360 RPM
2nd — 300-1200 RPM
3rd — 900-3600 RPM
4th — 3000-12000 RPM
Feet per minute—one half the dial reading with use of 6" disc wheel.

Advantages: Accuracy—±0.5% • Stop button feature • Instantaneous readings • 3" easy to read dial • Light—approx. 14 oz.

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CIRCLE 140 ON READER-SERVICE CARD

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Many Temperature Controllers, Precision Indicators, Continuous Line & Multiple Point Recorders; Leeds & Northrup Speedomax, Micromax; M.H. Brown Electroniks, and other makes. Also Strain Gauge Recorders & Potter Flow Recorders & Indicators.

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CIRCLE 141 ON READER-SERVICE CARD

POWER AMPLIFIERS. Bulletin EE 1009 details operation and application of mechanical power amplifiers, commonly used input sources, potential applications and basic advantages of mechanical operation contrasted to other devices for amplifying power. —Electronics Div., Seneca Falls Machine Co., Seneca Falls, N. Y.

CIRCLE 326 ON READER-SERVICE CARD

PLUG-IN UNITS. 32-page booklet details 16 Tektronic "A-to-Z" plug-in units and includes specs and performance characteristics with waveform patterns and other illustrative material for various measurement applications.—Tektronic, Inc., Box 500, Beaverton, Ore.

CIRCLE 327 ON READER-SERVICE CARD

ELECTRICAL, ELECTRONIC COMPONENTS

MEASURING COMPONENTS. 16-page Condensed Catalog summarizes line of oscillators, sweep drives, data recorders, pulse equipment, variacs, speed controls, etc.—General Radio Co., West Concord, Mass.

CIRCLE 328 ON READER-SERVICE CARD

DC MAGNETIC AMPLIFIERS. 2-page Bulletin M-24 describes low level FERRAC magnetic amplifiers which provide linear outputs of ±7.5v dc with input signals in the low millivolt range. Transfer curves, electrical connections, dimensions, detailed specs are provided.—Airpax Electronics Inc., Seminole Div., Fort Lauderdale, Fla.

CIRCLE 329 ON READER-SERVICE CARD

TRANSDUCERS. 28-page catalog lists models and explains principles of pressure transducers, accelerometers, load cells, amplifiers, etc.—Statham Instruments, Inc., Application Engineering Dept., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 330 ON READER-SERVICE CARD

INDUCTION POTENTIOMETERS. 2-page Bulletin S-606 provides specs for 12-v UH-16 and 6-v UH-18 induction potentiometer transducers. Both units feature an absence of sliding or wearing parts, temperature error of less than 0.01%/°F within the range −65° to +275°F, and a combined linearity, hysteresis, friction and repeatability error of less than ±1.0%. —Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif.

CIRCLE 331 ON READER-SERVICE CARD

LANGUAGE LAB COMPONENTS. 4-page brochure outlines new concept in language laboratory components offering convenient, simplified, portable and low-cost language lab setup.—Switchcraft, Inc., 5555 N. Elston Ave., Chicago 30, Ill.

CIRCLE 332 ON READER-SERVICE CARD

PYROMETERS
BOUGHT—SOLD—SERVICED
Immediate Shipment of Rebuilt Pyrometer Equipment From Stock
—LIST ON REQUEST—
PYRO SERVICE CO.
17121 Greeley, Detroit 3, Mich.

CIRCLE 142 ON READER-SERVICE CARD

MISCELLANEOUS

STATION MAGNETOMETERS. 4-page Data Sheet V-4931 and V-4931 Price List describe mobile V-4931 (proton) station magnetometer; 4-page X-4934 Data Sheet describes the fixed-position V-4934 (Rubidium) model. 2-page Geophysical Tech Memo No. 5 outlines application for the M-49 portable magnetometer (towing sensing head behind a boat).—Instrument Div., Varian Associates, 611 Hansen Way, Palo Alto, Calif.

CIRCLE 333 ON READER-SERVICE CARD

INSTRUMENTATION CONSOLES. 4-page brochure describes construction and specs of modular and mobile consoles that provide protection against shock and vibration as well as ventilation and cooling for electronic instrumentation.—Esco Eng. & Mfg. Co., 6550 S. Stalford Rd., LaGrange, Ill.

CIRCLE 334 ON READER-SERVICE CARD

INSTRUMENT AIR CONDITIONERS. 4-page Bulletin 7 describes compact, high pressure, inexpensive-air scrubbers and dehydrators.—Robertson Mfg. Co., Box 14663, Houston, Texas.

CIRCLE 335 ON READER-SERVICE CARD

TIME PROGRAMMER. 2-page Bulletin 3004-A-5 describes the MicroSADIC/Time Programmer.—Consolidated Electrodynamics Corp., a Subs. of Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 336 ON READER-SERVICE CARD

ELECTRIC CONTROL SYSTEM. 4-page Bulletin E74-1 describes the Bailey 720 solid-state electric control system.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

CIRCLE 337 ON READER-SERVICE CARD

CONTROL CODE PRINTER. 2-page Bulletin 130 describes Identicharts which print a code number on strip charts.—Royson Engineering Co., Hatboro, Penna.

CIRCLE 338 ON READER-SERVICE CARD

MEMORY CORE HANDLER. 2-page Bulletin 60-A describes Model CH-58 automatic memory core feeder.—Rese Engineering, Inc., 731 Arch St., Phila. 6, Pa.

CIRCLE 339 ON READER-SERVICE CARD

RADIATION MEASUREMENTS. 88-page General Catalog 61 describes radiation detecting and measuring instruments.—Radiation Instrument Development Lab., Inc., 61 East North Ave., Northlake, Ill.

CIRCLE 340 ON READER-SERVICE CARD

DISPLACEMENT TRACKER. 12-page advance technical release describes and illustrates Model 650 tracker.—Optron Corp., 335 South Salinas St., Santa Barbara, Calif.

CIRCLE 341 ON READER-SERVICE CARD

INSTRUMENT ENGINEER

Some years experience required. To have charge of instrument maintenance at chemical plant in Ohio Valley.

Send resume to P. O. Box #382.

ICS INDUSTRY NEWS

HYDROMATICS has appointed *John A. Wiedmann* chief engineer of the industrial division.

JOHN A. WIEDMANN
Hydromatics

KEITH A. NEAL
Consolidated Electrodynamics

CONSOLIDATED ELECTRODYNAMICS has appointed *Keith A. Neal* marketing director of the data processing divisions.

DAYSTROM, INCORPORATED announces election of *Thomas Roy Jones* as chairman and of *John B. Montgomery* as president.

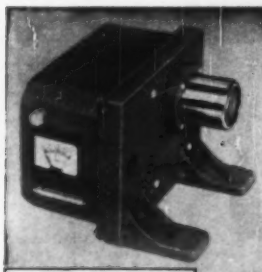
SAMA has given Past Chairman Awards to former heads of the Recorder-Controller Section. Picture shows (l. to r.) *Raymond E. Olson*, Taylor Instrument Cos.; *Henry F. Dever*, Minneapolis-Honeywell Regulator Co., *William*

H. Faeth, The Bristol Co. (present chairman); *Benjamin H. Bristol*, The Foxboro Co.; and *George W. Tall, Jr.*, Leeds & Northrup Co. Also honored, but not present at the time of presentation were: *Paul S. Dickey*, Bailey Meter Co., *George S. Hendrickson*, Republic Flow Meters Co.; and *Lewis B. Swift*, Taylor Instrument Cos.

COOPER DEVELOPMENT DIV. of *Marquardt Corp.* announces that the division will move from Monrovia to Van Nuys.

Frederick G. Merckel

Frederick G. Merckel, 64, director and retired president of Wallace & Tiernan Inc., died October 29, 1960 on a business trip in London, England. Mr. Merckel joined Wallace & Tiernan in 1921 as a sales engineer and was later made manager of the Chicago sales office. In 1930 he returned to the main office in Belleville, N. J. In 1954, when Wallace & Tiernan became a publicly owned company, he was elected to the office of president.



Photoelectric Control with added "FAIL SAFE" protection

Photoelectric Controls for Every Purpose

Including tension jam-up, sorting, measuring, inspecting, weighing, die-protection, smoke detection, packaging, processing.

Send for catalog describing wide selection of standard equipment including photoelectric controls and light sources for all kinds of conditions.

Increases protection against accidents due to tube or circuit failure.

Automatically assumes open circuit position with current variation normally caused by loss of emission, filament burnout, lamp failure, shorting within a tube or a defective component.

Built-in ammeter provides instant check of photoelectric current which can be adjusted to normal without opening case.

Available with self-contained or remote phototube heads and with light sources adaptable to a wide range of service requirements.

Send for Catalog or tell us what you want to do.

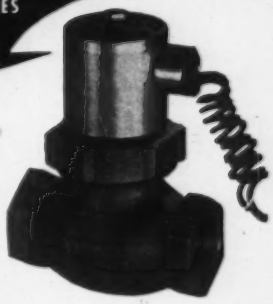
AUTOTRON, INC.
Box 722 QK Danville, Ill.

CIRCLE 143 ON READER-SERVICE CARD

Check these prices on Gould Type M

Solenoid Valves

TYPICAL USER NET PRICES
F. O. B. FACTORY



SIZE	1 to 5	100 to 499
½"	$15.40	$11.15
¾"	18.50	13.60
1"	24.25	18.50
1½"	48.00	42.40

2-Way • General Service
Packless • Normally Closed

Sizes ⅜" to 3" • Temperatures to 250° • Pressures to 400 psi • Molded epoxy resin water-proof coils • Unbreakable piston rings • No damaging hammer • Easy-off "O" ring bonnet construction in sizes ⅜" thru ¾" • High temp coils and explosion proof housings available. Immediate delivery. Ask for Bulletin 600-M.

SOME OTHER TYPES OF GOULD SOLENOID VALVES

D—Adjustable flow control, adjustable cushioning control to reduce shock, manual opening. **HV**—Four independent controls—opening, closing, flow, manual opening. **G**—Stainless, fractional ports, pressures to 1,000 psi. **GX**—All 316 stainless, fractional ports. **K**—Stainless, ½" to 2". **MDW**—Direct acting. NOTE: Special assemblies for exacting requirements.

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GOULD SOLENOID VALVES

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CIRCLE 144 ON READER-SERVICE CARD

YOU CAN DEPEND UPON PM

EXTREMELY HIGH PRECISION VOLTAGE REFERENCE SUPPLY ... THE PVR-10

Eliminates dry cells, standard cells and standardization circuits in recording, measuring and controlling instruments.

The PVR-10 offers an extremely stable output under varying line voltage conditions. It eliminates dry battery-standard cell voltage reference systems, using long-life solid state regulator. The PVR-10 is also low in noise and perfect for use with high sensitivity instruments and has high temperature operating-stability. It's life is unaffected by any temperature the instrument will withstand. Use with potentiometer-type recorder-controllers; Leeds and Northrup, Brown, Minneapolis Honeywell and others.

$89.50 F.O.B. DETROIT

SPECIFICATIONS

OUTPUT: 1.050 volts adjustable ± 0.04V.
STABILITY: Within 0.08% with simultaneous variations of 107 to 127 volts, 48 to 64 cycles and temperatures of 16° C to 75° C.
NOISE: Less than 0.0013% ripple at 60 cycles and 0.0007% at 120 cycles. Less than 0.075 gauss magnetic field at 60 cycles of any phase and in any direction.
ISOLATION: Leakage less than 100 picoamperes D.C. from output to ground and less than 20 nanoamperes A.C. from output to ground with unit operating. Will withstand 2000 volts rms between input and output and/or ground.

THE STANDARD MODEL CVR-610

has become a very popular replacement for the dry battery in instruments retaining the standardizing circuit.

SPECIFICATIONS

OUTPUT: 1.5 volts D.C. nominal will supply either 6 or 10 MA circuits.
STABILITY: Within 0.1% with line variations from 105 to 125 volts, 50 to 60 cycles.
NOISE: Injects less than 10 microvolts into standard measuring circuits.
TEMPERATURE: Minus 20 to +140° F.

$62.50 F.O.B. DETROIT

PM produces instruments to measure: LOAD • THRUST • TORQUE • FLOW WEIGHT • TEMPERATURE • DISPLACEMENT VOLTAGE • PRESSURE with the highest accuracy attainable in industrial and laboratory applications.

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PERFORMANCE MEASUREMENTS COMPANY

15120 THIRD AVE. DETROIT 3, MICHIGAN

CIRCLE 145 ON READER-SERVICE CARD

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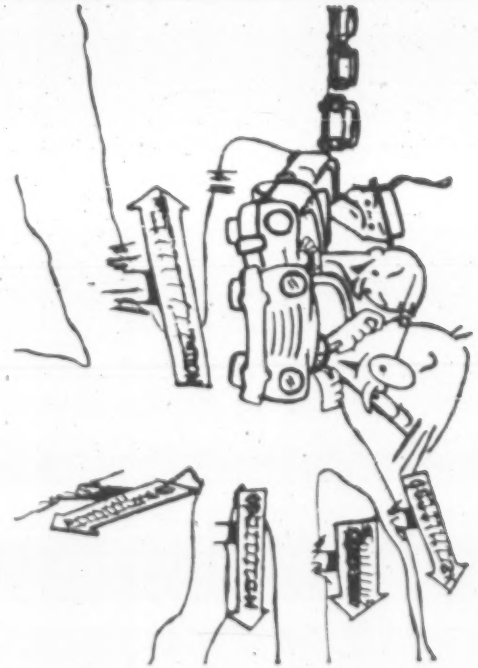

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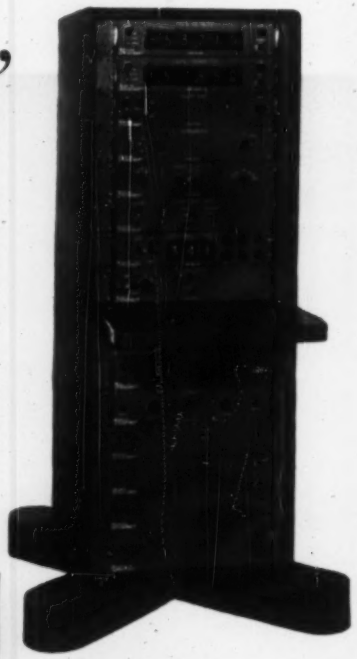

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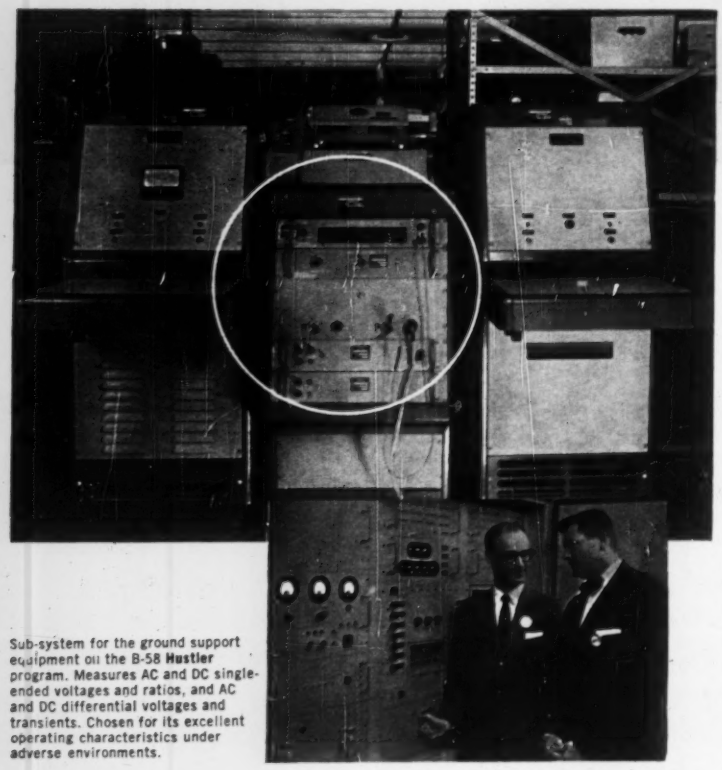

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